The Migration of Birds.

Charles Dixon

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THE MIGRATION OF BIRDS

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AN ATTEMPT

To Reduce Avian Season-Flight to Law

By CHARLES DIXON

AUTHOR OF

'RURAL BIRD-LIFE,' 'EVOLUTION WITHOUT NATURAL SELECTION,' 'OUR RARER BIRDS,' 'ANNALS OF BIRD-LIFE,' 'STRAY FEATHERS FROM MANY BIRDS,' 'IDLE HOURS WITH NATURE,' 'THE BIRDS OF OUR RAMBLES,' 'THE GAME BIRDS AND WILD FOWL OF THE BRITISH ISLANDS,' ETC.

PART AUTHOR OF 'A HISTORY OF BRITISH BIRDS.'

"... Wild birds that change
Their season in the night, and wail their way
From cloud to cloud. ...."

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PREFACE.

There is no branch of Ornithology more popular than that which treats of the Migration of Birds. To the genuine lover of birds there is no more fascinating pursuit than to watch the comings and the goings of his favourites; to the more scientific ornithologist Migration is not only an intensely interesting proceeding in itself, but a function fraught with importance in the History of Avian Life. In many instances it is an indicating medium of affinities, an explanation of various apparent anomalies in geographical distribution, and unquestionably an evidence of those vast physical changes which have been one of the dominating features of our planet's history in past ages.

Notwithstanding the immense popularity and importance of Migration, strange as it may seem, no work has hitherto been devoted expressly to its discussion. A very large amount of material

bearing on Migration has been recorded, and an equally large amount of observations has been made on this grand Avian Movement, but hitherto, so far as I am aware, no naturalist has endeavoured to grapple with the entire Phenomenon, or to record the result of its general study in book form. I am well aware of Palmén's endeavours, of Gätke's efforts, but both these distinguished naturalists have only dwelt upon a portion of the subject. I am equally cognizant of the researches of Weissemann, Harvie-Brown, Cordeaux, Seebohm, Coues, and Allen, and a host of others; yet none have sought to exhaust the subject, even superficially, or to bring our present knowledge of Migration within the limits of order, or to reduce it to Law.

In the present volume I have made an attempt to do this. It embodies the results of twelve years of diligent general study and research, and of at least two years' close application and thought, and will, I earnestly hope, serve at least the humble purpose of paving the way towards a more important record. The deep interest attached to the important function of Avian Hibernation has, I hope, been revived. It would have been an easy matter to have doubled the size of the present work had I

elected to clothe my facts more heavily with incident, or to confirm my views and opinions more emphatically with many additional instances. I trust, however, that the elaborateness and length at which the various points have been treated will at least be sufficient to create interest, to stimulate research, and to illustrate the Phenomenon of Migration sufficiently well. I am deeply indebted to a great number of illustrious workers at the subject, not only for material which they have furnished in their published records, but in various other ways, and all of which I trust has been fully acknowledged. To several valued and distinguished direct correspondents my thanks are also due. In the course of my study of Migration many bye-paths of research have been suggested, which it has only been possible to indicate and not to follow. One thing, however, has impressed me profoundly during my years of investigation. In my opinion the study of Migration foreshadows great discoveries relating to the Origin of Species, and the present and past distribution of Life over the earth's surface.

The whole subject of Migration is so vast, so wide-reaching, and so complicated, that it would be absurd to regard it as exhausted, and the present

volume must be looked upon only as a pioneer. If I have failed thoroughly to grasp its Philosophy, its History, and its Purpose, may I at least be allowed to claim the credit of honestly endeavouring to rescue its mass of raw and tangled data from chaos, and to reduce them to some kind of system and Law. No one is more conscious than the author himself of the little that has been done, and of the amount of work that still remains to be accomplished; but if the present effort forms a basis for more elaborate study and detailed research, its end and purpose will have been amply attained.

CHARLES DIXON.

July, 1892.

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ANCIENT AND MODERN VIEWS ON MIGRATION.

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Six hundred years before the Christian Era, the arrival and departure of migratory birds had undoubtedly arrested the attention of mankind, and the comings and goings of certain species specially remarkable for their periodical flights then as now, were the subject of allusion by the Divine writers of the Holy Scriptures. In simple yet eloquent language the Migration of birds is thus commented upon by the prophet Jeremiah : "Yea, the Stork in the heaven knoweth her appointed times; and the

Turtle and the Crane and the Swallow observe the time of their coming." There can be little doubt that the migration of birds was equally well observed in even more remote ages, and long before the economy of birds became a subject for scientific investigation, or Ornithology was even in its earliest infancy. For we are informed that the Persians and the Arabs were in the habit of compiling portions of their calendars from the times of arrival and departure of migratory birds, and that the date of their appearance was marked by certain festivals held in honour of the return of a warmer season which these feathered wanderers unerringly proclaimed.

It is rather a remarkable fact that these earliest observers of migration are in no way responsible for the mystery, superstition, and wild incredible theories that have been interwoven with the periodical movements of birds or propounded in explanation of the phenomenon. With the gradual growth of Ornithology as a science the wildest opinions have been expressed, and the most absurd theories put forward concerning migration. From the very earliest times the migration of birds has been a subject endowed with no ordinary degree of fascination for even the most casual observer of animal life. Birds came and went at their appointed seasons, but their destination was cloaked in the impenetrable mystery that surrounded so great a part of the earth's surface in those early days of modern science. Remarkable

as it may seem to naturalists nowadays, it was gravely asserted, not a century and a half ago, that the moon was supposed to be the destination of migratory birds! More than 300 years ago, we hear of Belon watching with interest the great flights of various Raptorial birds migrating to and from their winter quarters. About a century and a half ago, dear old Gilbert White, Thomas Pennant, and Daines Barrington, the fathers of British Field Natural History, were busily engaged in watching the movements of migratory birds, corresponding with each other on the subject, and deeply engrossed with the fascinating pursuit. Scores of other observers of less eminence in the scientific world, but none the less earnest in their endeavours, were studying the periodical flights of our commoner birds of passage. Continental field naturalists before and contemporaneous with the great Linnæus, were similarly employed; and although their researches were not very systematic or elaborate, we have ample evidence to show that the subject was one of no ordinary interest to them. From the distant days of Gilbert White, who in his peaceful Hampshire home noted with loving care the comings and the goings of our feathered hosts, and never neglected an opportunity of pursuing his search after migration knowledge, down to our own, covers the greater part of 200 years, and now as then the subject has lost no portion of its charm. In spite, however, of the great pains taken by these early observers, the philosophy of

migration still remained but little understood, and it may be safely asserted that only within the past twenty years or so has any real light been thrown upon the subject.

Probably no other portion of the economy of birds has been surrounded with so much mystery as that which embraces their periodical journeys to and fro. The various migratory birds were wont to disappear at stated seasons, and to re-appear at others. Such movements were too palpable to be denied. The Cuckoo appeared in spring, and just as surely vanished from the woods and fields in early autumn; so likewise did the Swallows and the Swifts, and the various small birds that swarm in our islands with each recurring summer. Before the geographical distribution of birds had advanced to the dignity of a science, before the uttermost parts of the earth were scrutinized by competent observers, and the avifaunas of wide tracts of country became known through the indomitable pluck and perseverance of collectors, the destinations of these birds of passage were very imperfectly known; and little surprise can be felt that men sought to explain the disappearance of these birds in another way. In other words the Cuckoo, the Swift, and the various species of Swallows were said not to leave this country at all, but actually to spend their winters with us, either, as in the case of the Cuckoo by becoming transformed into a Hawk, or, as in the case of the Swifts and Swallows by sinking into

a state of torpidity for the cold season. We may at once dismiss the theory of seasonal transmutation as being utterly false and worthless, although it is soberly believed in even at the present day by many country folks. It probably originated in the close resemblance of the Cuckoo to the various species of smaller Hawk, and viewed in this light is not so very outrageous after all.

The presumptive habit of Hibernation, however, cannot be so curtly dismissed. For upwards of 250 years the hibernation of birds has more or less excited the curiosity of man, and amongst its most ardent supporters may be found the names of men, neither knaves nor fools, but eminent for their scientific knowledge, or renowned for their labours in the field of Ornithology. Animals both lower and higher in the organic scale than birds are known to hibernate, or to pass the cold winters of the northern hemisphere in a state of torpidity. Bats, dormice, and various other mammals are in the habit of regularly hibernating in some snug retreat during the winter months, in many cases making elaborate provision for their trance; various reptiles, batrachians, and insects hide themselves away at stated periods and sink into lethargic slumber. In the hibernation of birds therefore we have nothing absolutely impossible, either from a physical or a physiological point of view; and it is by no means improbable that the habit may have been a prevailing one in northern regions during much colder periods than we now experience, and

before migration began. Nay, more, it may have been an inherited faculty from semi-reptilian ancestors now almost become obsolete. The supreme disdain of modern naturalists, almost without exception, for avian hibernation, and the contemptuous way in which they pass the matter by as too utterly absurd for serious notice or refutation, is much to be regretted. No careful student, anxious for truth at any cost, can afford entirely to ignore the mass of evidence accumulated by our forefathers in support of the hibernation of birds; and it seems to the present writer most unwise and most unscientific to consign all this confirmatory material, much of it of the most positive and conclusive kind, to the limbo which contains such absolutely proved fables as the tree-grown Bernicle Goose, the Phœnix, and the Griffon. To many naturalists it may therefore seem undignified to discuss such a subject in sober earnest at all in the present year of grace, and in the highest degree unorthodox to seek to resuscitate a theory so seemingly marvellous, so wildly improbable, as the seasonal torpidity, or periodical decline of vital activity, in certain members of the class Aves!

It is difficult to say how long ago hibernation was first attributed to birds, but it is probably a very ancient assertion, inasmuch that it is alluded to by Aristotle as an opinion prevailing in some countries, and one Olaus Magnus, a northern naturalist, strongly asserted the subaqueous hibernation of Swallows; there is evidence that this

peculiar habit was believed in hundreds of years ago in Scandinavia, Germany, and elsewhere. Such accomplished men as Linnæus, Buffon, and Cuvier, were supporters of the theory. The whole subject has been repeatedly discussed before such illustrious bodies as the Royal Society of England and the French Academy of Sciences, finding a place in the archives of each. Positive statements have also been recorded in our own *Philosophical Transactions*, as well as in the Memoirs of the American Academy of Arts and Sciences, and elsewhere. Again, it is not a little remarkable that, speaking so far as the British Islands are concerned, of some twenty-five common summer migrants, the Swallows (collectively), and Swift (*Cypselus apus*), are almost the only species that have been said to hibernate. Now hibernation was attributed to birds in our islands so early in the annals of Ornithology that the probability is these species were the only ones whose disappearance in autumn was remarked at all. No other birds that visit us in spring are so noticeable as these birds: they spend their lives in the open, coursing about the air, and haunting the very dwelling-places and cities of men. Small wonder then that their appearance in spring and their disappearance in autumn so regularly and so suddenly fixed the attention of observers, and excited their curiosity. The migration of birds was little understood in those days, and double flights of five thousand miles between Africa and England were yet undreamed of.

Before proceeding further with this interesting subject, it will now be necessary to say a few words on what avian hibernation really consists of. Hibernation, according to the testimony of observers, may aptly be divided into two kinds. The first division we may designate as subaqueous hibernation, in which birds were said to plunge under the surface of water, and to bury themselves in the mud at the bottom. The second division we will call terrestrial hibernation, and is similar to that prevailing amongst bats and various other mammals, in which birds were said to hide themselves away in crevices of rocks, in hollow trees, and such-like warm and sheltered nooks, there to sink into lethargic slumber until the return of a warmer temperature. So far as the actual process of hibernation is concerned, it does not appear to differ in any way from that undergone by bats or other mammals; the vital functions are partially arrested, animation is suspended, and a death-like trance or stupor, a lethargic sleep, eventually supervenes. Birds that are said by observers to have been discovered in this state, have slowly regained animation upon being subjected to a warmer atmosphere or to any external heat.

It would be a very easy matter to fill scores of pages with what appear to be well-authenticated instances of the hibernation of birds; but it will be sufficient for our purpose to allude to a few of the most striking and authoritative ones. In 1666, Schefferus records in the *Philosophical Transactions*,

that Swallows sink into lakes in autumn, and hibernate in a manner precisely similar to frogs. In 1741, Fermier-Général Witkowski made legal testimony to the effect that two Swallows had been taken from a pond at Didlaeken in his presence, in a torpid state; that they eventually regained animation, and after fluttering about, died some three hours after their capture. In 1748, the great Swedish chemist Wallerius, wrote that he had on several occasions seen Swallows clustering on a reed, until they all disappeared beneath the surface. In 1750, Kalm the traveller observed Swallows on the 10th of April, sitting on posts near the sea, with their plumage wet as though they had just emerged from the water. Four years later, J. R. Forster (editor of Kalm's *Travels in North America*) was an eye-witness, so he informs us, to the following. In January 1754, several Swallows were taken from the lake of Lybshau, then covered with ice, one of which he carried home, where it regained its vitality, but died soon afterwards. In 1764, Achard, referring to Swallows on the Rhine, states that they have been found apparently stiff and lifeless in holes in sand-cliffs, ultimately becoming reanimated. This record doubtless refers to the Sand Martin (*Cotyle riparia*), and is interesting. Between the years 1767 and 1780, Gilbert White's letters to Thomas Pennant and Daines Barrington (the latter then a vice-president of the Royal Society of England) contain many references to the hibernation of birds, and clearly show that

the old Hampshire naturalist, one of the most practical, painstaking, and reliable observers of Nature that ever lived, believed implicitly in the habit, although, in spite of much careful investigation, no direct proof of its truth was ever obtained by him. Both Pennant and Barrington were also supporters of the hibernation theory. It should, however, be remarked that both White and Pennant were cautious enough to say that the habit was by no means universal with the Swallows and Swift. In White's letter to Pennant, dated November 4th, 1767, the following passage occurs: "I acquiesce entirely in your opinion that, though most of the Swallow kind may migrate, yet that some do stay behind, and hide with us during the winter." And again in his letter to Daines Barrington, dated March 9th, 1772: "From repeated accounts which I meet with, I am more and more induced to believe that many of the Swallow kind do not depart from this island, but lay themselves up in holes and caverns, and do, insect-like and bat-like, come forth at mild times, and then retire again." After his long life of assiduous observation, White sticks to his honest belief in hibernation, and writes only thirteen years before his death: "Summer birds are, this cold and backward spring [1780], unusually late; I have seen but one Swallow yet. This conformity with the weather convinces me more and more that they sleep in the winter."

For the next fifty years, ornithological literature is fairly well sprinkled with notes on the hibernation

of Swallows and other birds, among the most interesting and precise being the reputed discovery on the 16th November, 1826, of five Barn Swallows (*Hirundo rustica*), huddled together in a torpid state on one of the rafters supporting the roof of a cart-shed near Loch Awe, in Scotland. These birds were said to remain some time in an apparently lifeless state, until the warmth of the room into which they had been carried roused them into activity. Other instances of Swallows being found in a state of torpor in a hollow tree at Belleville, in North America, and of Sand Martins (probably) in a sand-bank near Stirling, are worthy of passing mention. Two instances of Corn Crakes (*Crex pratensis*), reputed to have been discovered in a state of hibernation, are recorded in the *Edinburgh Journal* (vol. viii.). The first example was found in a mud wall at Aikerness, in the Orkneys; in the second instance, three of these birds were found in a dung-heap that had long remained undisturbed at Monaghan, in Ireland. All these birds were in a state of torpor, but revived under the influence of a warmer atmosphere. Reputed instances of Humming Birds (TROCHILLIDÆ) becoming torpid when overtaken by cold, are recorded in the *Philosophical Magazine* for 1805 (vol. xxii.).

For the next fifty years but little was heard of the hibernation of birds; its supporters were either dead and gone, or the theory had been so pilloried by modern naturalists that, as Dr. Coues forcibly remarks, it was as much as a virtuous ornithologist's

name was worth for him to so much as whisper hibernation, torpidity, and mud! In 1877, however, with the publication of Palmen's *Ueber die Zugstrassen der Vögel*, the subject was again brought into prominence before British ornithologists by an anonymous reviewer of the work in *Nature*, and once more the theory was subjected by him to the bitterest ridicule, and denounced as folly. Three weeks afterwards, in the same publication (*Nature*), the Duke of Argyll transmits a letter from Sir John McNeill, wherein the latter gentleman explicitly states that he has seen Swallows hibernating in large numbers. I am indebted to the Duke of Argyll for the following interesting details. "I have an anecdote to refer to on the authority of my late brother-in-law, Sir John McNeill, who told me that many years ago when travelling in the East, he had occasion to cross the Tigris or Euphrates, I forget which, and that he saw a large slice of the muddy bank which had been undermined by the current fall away—exposing to view many Swallows which were dormant in holes in the mud, and of which he picked up a number with his own hands. That Swallows do generally migrate when they leave us is an ascertained fact. That they *can* live in a dormant condition, or do *ever* hibernate, is not believed by naturalists, and I doubt if any evidence but their own eyesight would convince them. Sir John McNeill also told me that he once saw a Hoopoe fly into the hole of a tree at Teheran, in Persia,

and that when he went up to the tree the bird was already so comatose that he caught it by the hand. This, however, may not have been connected with any hibernating habit, as a similar circumstance has twice occurred to myself with two very different species. One was a Greenfinch, and the other was a Nuthatch. I saw a small flight of Green Linnets fly into a bush on the shore at San Remo, and on going up to the bush, I found one of them apparently asleep or paralyzed, and caught it with the hand. My son kept it tame for years, and the bird was quite well. The Nuthatch I saw in a similar condition, hanging head downwards from a twig in my garden in London. This bird I also caught in my hand, and put it into a cage. But its condition was so transient that it pecked its way out of the bottom of the cage the same night, and escaped. The Hoopoe story, therefore, may have nothing to do with hibernation, although Sir John did so interpret it. But the story of the dormant Swallows in the holes of a mud-bank would seem to be one of true hibernation, and it is difficult to imagine that his memory could have been deceived in such a matter. I believe the still-living Sir Henry Rawlinson, the celebrated Oriental scholar, was also present at the time. I think it clear, however, that migration is the almost universal rule with birds. Hibernation must be a very exceptional circumstance."

In the *Ornithologisches Centralblatt* for May 1st, 1877, Rohweder certifies to the accuracy of the

observer who had furnished him with information concerning the hibernation of birds therein described. Both these latter incidents were dealt with in a hostile spirit a few weeks later in *Nature*, by Palmen's reviewer. In 1878, the hypothesis of hibernation received by far the most powerful support ever accorded to it in modern times, in the writings of Doctor Coues, an American ornithologist, and one of the most accomplished and industrious naturalists this or any other century has produced. In his first part of the *Birds of the Colorado Valley*, he not only goes very fully into the presumptive habit of hibernation, but he gives the theory all the support of his authority as an ornithologist of the highest eminence. He there boldly states his belief (and I am not aware that he has seen fit to change his opinion), that the American Chimney Swift (*Chætura pelagica*) hibernates in hollow trees, basing his opinion on the fact that this species is not known to winter anywhere out of the United States, nor is it found anywhere in them at that season; and of its swarming in myriads in hollow trees, and sometimes perishing in those places in such numbers that their remains form solid masses several feet in thickness at the bottom! It is, however, only fair to say that Dr. Coues, just like Gilbert White, is not by any means a convert to the belief in universal torpidity, but considers that in the majority of cases it is only odd individuals that do so hibernate. As he forcibly remarks, the migration of a million Swallows

into Africa does not prove that some other Swallows cannot hibernate. Unfortunately no direct evidence of torpidity has ever come under this naturalist's observation.

The following extract is from the *Dundee Advertiser* of April 1884. "About four o'clock in the afternoon of the 13th or 14th of March, the light-keeper on duty at the Bell Rock Lighthouse observed a Swallow fluttering in front of the kitchen window. After watching it for some little time, he opened the window and stood aside to see if the bird would come in. This in a minute or two it did, and alighted on the inside of the window-sill. So exhausted did the little wanderer appear from its long flight [?] and the buffeting of the weather, that it allowed itself to be lifted up and put into a cage. It immediately lay down on the bottom of the cage and instantly fell fast asleep, remaining in this state till next morning about eight o'clock (sixteen hours). So sound were its slumbers that the keepers watching it as it lay could scarcely detect any signs of life in it, and at times they were almost certain that it had died. On awakening at the hour mentioned, the Swallow was taken out by one of the keepers and given a drink of water. It was put back into the cage again, where it lay in an apparently dormant condition till 10 a.m., when it was supplied with more water, under the influence of which, and the rays of the sun, it became quite lively and strong. The kitchen window was now lifted up, and the bird taken out and laid in the open hand of

Mr. Jack, principal light-keeper. Resting there for a moment, it gave one cheery twitter, and, springing upwards from the outstretched palm, it winged its way in the direction of the land, and was lost sight of in the space of a minute or two."

This bird may probably have spent the winter, dormant, near the lighthouse. Anyway we here have the most trustworthy evidence of a positive kind. If this does not indicate hibernation capabilities amongst certain birds, pray to what else can it be attributed? Birds normally sleep more lightly than any other creatures; the evidently profound slumber of this individual Swallow was highly abnormal, and undoubtedly of a lethargic nature.

There is another, and it seems to me suggestive fact which deserves notice. Incredulous as it may seem, it is nevertheless true, that the winter quarters of the two most northerly ranging Hirundines are practically unknown. The House Martin (*Chelidon urbica*) and the Sand Martin (*Cotyle riparia*) are known to breed in large numbers, in some cases literally to swarm in the Arctic regions, the former reaching latitude 70½° in Western Europe, and latitude 69° in Siberia; the latter 70° in Western Europe, 67° in Siberia, and in Kamtschatka on the Pacific coast. As is well known, these birds literally swarm in many districts during summer; they are obtrusive species by no means easily overlooked, yet nowhere do we either hear of them on passage, or have they been found in Africa, India, or elsewhere during the cold season in

any proportionate numbers. Is it possible that the most northerly birds hibernate and pass the long Arctic winter in torpidity as so many other boreal creatures are known to do? I express an opinion neither one way nor the other, but allude to the facts as suggesting an interesting field of inquiry. It has also been remarked repeatedly that abnormally early individuals of Corn Crakes and Swallows have been noticed in or near districts where unusually late ones were observed during the previous autumn.

The above may be taken as the pith of the evidence in favour of hibernation; it is now only fair that the evidence against it should be briefly discussed. I think we may at once dismiss subaqueous hibernation as applied to birds as a physical impossibility. The species on which this portion of the theory is based could not live for even a few moments under the surface; water is not their element; whilst the sudden arrest of vital activity and the abrupt transition from mercurial energy to torpor is absolutely fatal to the supposition that they should seek such a retreat. We have, however, the Duke of Argyll's interesting experiences of birds suddenly assuming a comatose condition, which may bear directly on hibernation under other conditions. The theory of subaqueous hibernation probably had its origin in the fact that Swallows are particularly fond of frequenting large sheets of water, especially in autumn, at which season vast numbers often resort

to reed and osier beds to roost. In skimming to and fro they often drink or bathe, and repeatedly strike the surface with their wings; this may have suggested a disappearance beneath the surface. Of course subaqueous hibernation as applied to amphibious animals is a different thing altogether, and, it need scarcely be remarked, is a well-established fact. Even terrestrial avian hibernation has at least one grave difficulty to contend against, especially when applied to Swallows, the very birds, by the way, to which it has been most widely attributed. These birds undergo their annual change of plumage during the months of February and March, whilst they are in their winter quarters, and it is scarcely conceivable that such a function could be performed during a state of torpor; although, in the case of Swifts, it may be remarked, Gilbert White suggested that they might perhaps retire to rest for a season, and moult in the interval. Swifts, I should say, however, moult twice in the year, and very slowly.

Strange, nay almost incredible as avian hibernation is, however, it must always be remembered that the evidence against it is purely negative; and that although it has not yet been sufficiently established to satisfy the sceptical science of to-day, it has never been refuted. Denials prove nothing, and all we can say is, until more satisfactory modern evidence of its truth is forthcoming, that birds are probably capable of hibernating under exceptional conditions, and may have done so, but this habit is

by no means a usual or a universal one, and very likely in most if not all cases has arisen not from choice, but from inability or strong disinclination to migrate at the customary period. Hibernation, so far as we can learn, only applies to a few individuals, and no species of bird has yet been discovered in which the practice is universal, if we except conditionally the Swift (*C. pelagica*), to which allusion has already been made. As for myself, I neither accept nor deny it, having personally seen nothing to refute or confirm it, although fully believing it possible, considering that such an attitude is the most scientific position to assume until the subject has been more fully investigated, even at the risk of being "handled without gloves" by some mud and torpor despising bruiser critic for my heresy!

Little if any less marvellous was that mysterious power ascribed to birds which enabled them to perform their journeys to and fro between continent and continent with such wonderful skill. Even at the present day there are many naturalists who implicitly believe in this miraculous power, and as a popular opinion it still prevails supreme. Birds are said to be endowed with the superhuman faculty of finding their way across the sea to their winter quarters; or setting off as each migration time returns for a flight of many thousands of miles with nothing but their inborn perception or blind instinctive impulse to guide them on the way. In short, birds at the present day are still popularly

supposed to migrate by "instinct," knowing not how or why, impelled along a course that never errs or changes, flying from point to point with no more mental effort than a piece of inanimate mechanism, hurrying away as an arrow from a bow, and just as incapable of swerving from their track until their flight is done. Were such a miraculous power really possessed by birds, then of a surety they would be transcendently more endowed with mental attributes than Man, creation's Lord himself! Ascribing such a faculty to these creatures means on the one hand exalting them to a superhuman height of intelligence, or on the other hand degrading them to the passionless depths of mere irresponsible automata. Both courses are as unnecessary as they are unscientific and illogical. Migration is a Habit, and like all other habits has had to be acquired; it is, however, by no means a universal habit even amongst the individuals of many species; some migrating, others remaining stationary, according to the exigencies of their surroundings. Nay, more, we might almost say that uniformity is the exception rather than the rule. Were migration an inherited instinct, it is only reasonable to presume that it would be transmitted from parent to offspring in one unbroken and unchanging order of descent.

Let us glance at a few instances. The Robin (*Erithacus rubecula*) is a migrant in all the colder portions of its range, where the winters are sufficiently severe, passing for instance between Scandi-

navia and Africa with great regularity, but in milder climates, as for instance in the British Islands, it is stationary. The Sedge Warbler (*Acrocephalus phragmitis*) is a bird of regular passage, yet many individuals have suffered their migratory impulses to lapse, and reside permanently in parts of North Africa, in Corfu and Crete. The Blackcap (*Sylvia atricapilla*), although a bird of passage with us, and notwithstanding the fact that its migrations extend from about the latitude of the Arctic Circle to within some ten degrees of the Equator, is a resident in the basin of the Mediterranean. The dainty little Willow Wren (*Phylloscopus trochilus*), one of the most familiar of our summer birds of passage, whose migrations extend from nearly the highest point of continental land in Europe and Western Asia to the southernmost parts of Africa, in a fly-line of nearly 8000 miles, may be taken as one of the very best examples of migration, and yet in this species the habit is by no means universal, and many individuals are resident in North Africa, Spain, and Sicily. Just as remarkable is the Chiffchaff (*Phylloscopus rufus*); in most parts of its range it is a migrant, but many individuals are stationary in Southern Europe. Indeed, a few odd birds have been known to forego migration even in the British Islands and Germany, remaining to winter in the more sheltered parts of those countries. Then the beautiful little Goldcrest (*Regulus cristatus*) is only migratory in the colder parts of its range, being, as we know, resident in our islands;

but its numbers are increased in autumn by individuals from far across the sea. The Hooded Crow (*Corvus cornix*) is yet another instance of modified migration. In Scotland this bird is sedentary, elsewhere it is one of the most regular of migrants; vast numbers, for instance, coming to the eastern districts of England in autumn and returning in spring. Even the Magpie (*Pica caudata*) is a migrant in the northern and colder portions of its range. The Reed Bunting (*Emberiza schœniclus*) and the Common Bunting (*Emberiza miliaria*) are both examples of species in which many individuals are of regular migratory habits, whilst others are practically resident. Such a sedentary species as the Yellow Bunting (*Emberiza citrinella*) is in this country, is a regular migrant from the Arctic regions, retiring in winter to the South of Europe, Asia Minor, North-western Persia, and North-western Turkestan. The Ring Dove (*Columba palumbus*) is a regular bird of passage in the northern portions of its range, passing Heligoland in large numbers every autumn, and less abundantly in spring. Such a well-known migrant as the Corn Crake (*Crex pratensis*) is almost everywhere a bird of passage; but in Algeria, Palestine, and Asia Minor it is sedentary. The well-known Oyster-catcher (*Hæmatopus ostralegus*) is a resident on the British coasts, but the individuals spending the summer on the coasts of Arctic Europe and the Baltic Sea are birds of regular passage to Africa. In the same manner the Little Ringed Plover

(*Ægialitis minor*) is a bird of passage in the northern portions of its range, but resident in the basin of the Mediterranean, the migratory individuals extending as far north as lat. 60° in summer, and as far south as the Equator in winter. Even the Common Sandpiper (*Totanus hypoleucus*) is by no means uniformly migratory. Few birds are more regular in their appearance in spring upon our upland streams and pools than the dainty "Summer Snipe," and yet in the basin of the Mediterranean many individuals have dropped the habit of migration altogether, and have become sedentary. The Redshank (*Totanus calidris*) is even more irregular in this respect. In the north of its area it is migratory, but in the basin of the Mediterranean it is resident, and yet the winter passage of many individuals of this species extends south to the Cape Colony. Many individuals of various species of Ducks have also ceased to migrate, and have become residents in our islands within comparatively recent times. Among these may be mentioned the Tufted Duck (*Fuligula cristata*) and the Pochard (*Fuligula ferina*). In some cases the cessation of migration has led to physical change, and the segregation of local southern races. One instance of this I can here call to mind is the small Indian race of the Little Ringed Plover (*Ægialitis jerdoni*). Another instance is probably presented in the two races of Ringed Plover (*Ægialitis hiaticula*, and *Æ. hiaticula major*), the former migratory, the latter

sedentary. Many more instances might be adduced to show that Migration Habit is by no means universal, even amongst the individuals of a species; and even amongst the migratory individuals themselves the length of the journey varies to an astonishing degree, some travelling double or more the distance others travel. From the above facts, we may also propound the law that wherever the breeding area of a species intergrades with its winter range, migration among individuals breeding in the impinging districts has been suffered to lapse.

It is quite unnecessary here to deal with the modification that migration has undergone in past ages, having shown that it is not an unchanging habit, that it is not a transmitted power from parent to offspring in one immutable sequence; we need not therefore stay to inquire into its previous history as regards individual species, or even groups of the early ancestors of our existing avifauna. No doubt species have acquired the habit, and discarded it times without number in the course of their eventful descent from remote ages, according as conditions of life have favoured one or the other end. Birds migrate from necessity, not from choice; in confirmation of which fact I may mention that I do not know of any instance where some or all of the individuals of a species quit their breeding-grounds unless compelled to do so by severity of climate, failure of food, or both. The migrations of some species are shorter than others,

even from high-lands to plains only, yet the movement is a marked and regular one, and does not differ in kind from those extended flights of thousands of miles which other species habitually undertake. On the other hand, birds are excessively attached to their home, to the land of their birthplace and their love. Witness the fact of so many species (the Redwing, *Turdus iliacus*, and the Fieldfare, *Turdus pilaris*, are good instances) quitting their winter quarters in spring to return to their old home, although their young, so far as we can determine, could be just as successfully reared in our islands. Other interesting instances might be taken from the Waders, the Ducks, the Gulls, and Terns.

Instinct, again, is described as infallible. Migrating birds go and come with unerring certainty; they know their way by inherited impulse, and never fail to reach their destinations. But such is not the case. Birds blunder like human folk, lose their way, and perish in uncounted hosts, as we shall learn anon. The Homing Pigeon has been frequently brought forward in support of the inherited instinctive sense of direction possessed by birds in general. But this bird, wonderful as its performances of speed, distance, and endurance really are, has to be long and carefully trained for each successive stage of its prolonged journey before it can be safely entrusted to undertake it. During this training it gradually learns the various landmarks on the road, just as any human traveller might do; and if called upon to make the journey,

say in darkness or in fog, invariably declines to essay the task, or, in the rare event of it doing so, soon loses its way, its mysterious sense of direction being of course a myth. And so it is with migratory birds in general.

Amongst birds in which the habit of migration is dominant, the impulse to migrate is unquestionably instinctive, in the sense of being an hereditary desire transmitted from parent to offspring, which has become so deeply rooted in the uninterrupted course of countless ages of passage to and fro, that in many species nothing but death can eradicate it. Migratory birds if kept in confinement begin to grow restless and unsettled as the usual period of their departure draws nigh; the same irresistible desire is reflected in the gathering of the swallows in autumn; and the unwonted activity of other little feathered voyagers among the trees and hedges may be remarked by any one who takes the trouble to observe it. This desire to migrate gradually becomes an overwhelming desire, before which all other inclinations bow, and at last the great flight is commenced. But here instinct, hereditary desire, ceases its sway; reason, memory, knowledge of locality, and perception take its place. The mysterious portion of migration may now be thought to commence, as these little travellers depart for a distant land; but the process is simple in the extreme. It is sufficient for the present to say that all a bird's amazing powers of memory for certain landmarks and its knowledge of locality are brought

into play—powers, be it remarked, far more acute than any possessed by human intelligence, as the great journey progresses; and thus aided the wondrous flight is taken mile after mile along the old familiar way until the end of that long journey is reached. We shall return to this particular portion of the subject, and treat it more elaborately later on.

The antiquity of migration is profound. It is a habit connecting the present day with the immeasurable ages of the past, more ancient probably than any other, save that of reproduction—a habit that has been possessed from the very earliest infancy of Avian Life, maybe; handed down unchanged from a past so remote that the mind of man fails utterly to grasp its mighty measure. So soon as Birds, beings capable of *flight*, were evolved from their semi-reptilian ancestors, and circumstances arose which caused a change of habitat, the Migration of birds may be said to have begun, and to have continued from that remote past more or less intermittingly until the present day. The key therefore to the Habit of Migration must be sought in past ages, and as the subject is necessarily an important and an extensive one, a chapter must be set apart for its discussion.

CHAPTER II.

GLACIAL EPOCHS AND WARM POLAR CLIMATES.

The Origin of Birds—Fossilized Remains—Remote Terrestrial Changes—The Post-Pliocene Glacial Epoch—Warm and Cold Glacial Periods—Origin of Migration—Changes through Tertiary Time—Local Glaciation and Vertical Migration—Probable Future of Migration—Initiation of Migration in the CHARADRIIDÆ—Effects of Polar Darkness on Birds—Birds feeding at Dusk—Ancient Migrations—Migrations of Polar Birds—Ancient Species of CHARADRIIDÆ—Inter-Polar Migration—Mr. Seebohm's Glacial Theory of Dispersal—Isolated Species of CHARADRIIDÆ in the Southern Hemisphere—Shortness of Migration Flight in Southern Hemisphere—Gradations of Migration—Incipient Migration—Short Migration Flight—Long Migration Flight—Extended Migration Flight—Table of Migrants—Migration demonstrated—Return of Birds to Old Areas.

IF we accept the footprints upon the Bunter Sandstein of the Triassic System as evidence of the presence of Birds, then these creatures may probably date their origin from ages so remote as the beginning of the Mesozoic Period. Dr. Hitchcock enumerates the footprints of as many as twenty-three species of "birds" in the Triassic formations in New England. Some of these are of enormous dimensions (twenty-two inches in length), and in-

dicate creatures of vast size. Whether these giant Birds or Bird-reptiles, for we have no positive evidence of their structure, were capable of flight it is impossible to say. Whether they were sedentary or migratory in their habits is equally uncertain. In the Oolitic or Jurassic System, the ages of the gigantic Reptile and the Pterodactyl, a reptile-like bat, more definite evidence of the existence of birds is forthcoming in the famous fossil Archæopteryx. From this we pass on to the toothed birds of the Cretaceous System, all of which, however, appear to have become extinct before the Tertiary Period, in which occur the fossilized remains of birds closely allied to existing forms.

We need not concern ourselves with the effects of Glacial Epochs (even if such occurred, and the evidence against such phenomena having occurred earlier than the close of the Palæozoic Period is very conclusive, as will shortly be seen) previous to Miocene and Eocene ages; and what effects the mighty terrestrial changes may have produced on then existing life does not bear upon our present subject. That vast changes in the earth's surface and in her planetary movements took place in Miocene and Eocene ages, there is apparently sufficient geological and astronomical evidence to suggest; and in those remote ages Birds—creatures as we know them to-day—lived and flourished. We thus see that the Avian order of living beings has been subjected to many and varied geographical and astronomical disturbing influences from its

very earliest infancy. The Migration of Birds—a result of Change, as I hope soon to demonstrate—therefore dates most probably from Miocene or even from Eocene ages; for we know that during those periods vast alterations took place in the relative level of land and sea, that volcanic agency was remarkably active in altering the physical aspect of the northern hemisphere, and that climatic changes, due to varying phases of the earth's eccentricity and divergence of ocean currents, were considerable. The phenomenon of migration, however, must then have been very different from what it is in our day, and therefore, to understand it in its present aspect, we must pass on to a later period in the earth's eventful history. That in those mighty changes the habit of migration had its origin can scarcely be disputed, but much modification necessarily took place during the occurrence of the Glacial Epoch succeeding them. This we may call the Post-Pliocene Glacial Epoch.

That parts of the northern hemisphere have been subjected to a long and severe period of glaciation within comparatively recent geological time, is proved by the fact (among others) that the various species of Mollusca then living are the same as those we meet with in our own age; not only so, but numerous traces of ice movement have been preserved to us. It is 200,000 years ago since this Glacial Epoch is computed to have reached its maximum, and about 80,000 years since it came to a termination. We need not enter here into

details of the causes of Glacial Epochs, or of the various theories propounded to explain them. To such of my readers who may desire to acquaint themselves further with this portion of the subject, I would refer to Dr. Croll's *Climate and Time in their Geological Relations*, and to Wallace's *Island Life*, in which latter work especially the whole phenomenon is treated in an original and very masterly manner. Briefly stated, Glacial Epochs are caused by the slow and irregular periods of great eccentricity in the earth's orbit, combined with the precession of the equinoxes, and initiated by high land and unusual amount of moisture (which are favourable to the accumulation and storage of ice and snow) at the glaciated pole. It appears pretty certain that periods of high eccentricity cannot produce glaciation unless the land area of the pole with its winter in aphelion is favourably adapted, and the warm ocean currents have been diverted from the polar area. All the geological evidence hitherto collected is against the supposition that any one or more Glacial Epochs occurred during the Secondary and Tertiary Periods. As Wallace clearly demonstrates, this vast expanse of time seems to have been characterized by a uniform warm or temperate climate, admitting of a luxuriant vegetable growth up to the highest latitudes at present reached by man. The evidence points unquestionably to the fact that the Post-Pliocene Glacial Epoch was an exceptional phenomenon—no such vast and terrible

glaciation having ever previously occurred in north polar regions within geological time, although this view is not shared by many scientists, including Dr. Croll, who persists in his theory of intermittent or alternate glaciation following phases of high earth eccentricity. As Professor Nordenskjöld remarks (*Geological Magazine*, 1875)—"An examination of the geognostic condition, and an investigation of the fossil flora and fauna of the polar lands, show no sign of a glacial era having existed in those parts before the termination of the Miocene Period, [therefore] we are fully justified in rejecting, on the evidence of actual observation, the hypothesis founded on purely theoretical speculations, which assume the many times repeated alternation of warm and glacial climates between the present time and the earliest geological ages."

The Post-Pliocene Glacial Epoch seems to have been primarily brought about as follows. During the latter part of the Secondary Period a considerable elevation of land occurred in the Arctic regions, apparently the climax of a slow compact development of continental land, which not only barred several of the water passages to the north, but probably checked the flow of various warm ocean currents to this polar area, simultaneously with or just previous to a long phase of high eccentricity of the earth's orbit. From this evidence we may justly infer that birds have had only one experience of a Glacial Epoch, for the one preceding it was probably, if at all, during the Permian Period in

ages before birds were evolved. This Glacial Epoch, however, did not consist of one gradual change from a temperate to an ice climate which, having reached its maximum, again passed slowly away, but the earlier and later stages of the grand phenomenon were broken up into several alternative periods, during which warm and cold climates prevailed respectively in the area affected every 10,500 years in the precession of the equinoxes during this phase of the earth's high eccentricity. From the commencement of this Glacial Epoch, the Migration of birds, as we see it at the present time, was probably initiated. That these warm and cold Glacial Periods actually took place, we have abundant palæontological evidence, even in the British Islands. The fossilized remains of Hippopotami (*Rhinoceros hemitæchus*) and Elephants (*Elephas antiquus*) testify to the uniform temperate climate with little or no winter, just as the remains of Mammoths and Reindeer are indicative of a cold Arctic climate, with a short hot summer and a long severe winter succeeding it. There seems every inducement also to presume that during the Glacial Epoch the ice, once formed, never left the immediate regions of the Pole even during the several warm inter-glacial periods, which had such vast influence upon the climate of the sub-arctic zone.

From these remarks it may be gathered that we do not require even the occurrence of one Glacial Epoch to account for the Migration of birds. That a habit so deeply rooted, so universal, and so vital

to the well-being of such a vast number of species must have had its origin in a very remote past, the result of mighty climatic change and physical disturbance, seems not only absolutely certain, but the only rational explanation of the phenomenon. Such a cause amply sufficient in every respect is to be found in varying phases of Earth's orbital eccentricity in combination with the precession of the equinoxes—the grandest cycle of discovered Time, which in wondrous course entirely reverses the seasons of either hemisphere as the earth's polar axis describes a complete circle in the heavens. That these majestic phenomena are in any conceivable way connected with the migratory movements of birds seems utterly impossible; but in them the habit has its root; and the simple season-flight of a Cuckoo or a Nightingale to and fro between the shores of Africa and England is inseparably and directly connected with the erratic movement of a planet in its orbit; nay, with the constitution of a universe!

Of course in the utter absence of any data to fix the northern range of migratory birds in remote ages, it is impossible to give detailed explanations of the cause of the habit in each species, or even in many groups. Many local influences may have been at work; the gradual extension of range in various directions from a centre of dispersal owing to the rapid multiplication of a species may have driven many individuals into more northern regions where only a summer residence was possible; or even caused longitudinal movements necessitating

the acquirement of a migratory habit from more local causes. It will thus be seen that it is quite impossible to explain the origin of Migration in every species, or in an individual degree, but only to suggest its cause in the broadest sense. With Polar groups it is comparatively easy, as, for instance, in the CHARADRIIDÆ. But in all, broadly speaking, the habit had its origin either in direct climatic change, or in the exposure to a different and more severe climate due to Emigration. Again, some species must have acquired the habit sooner than others, just as we know at the present time the migratory flight of some birds is earlier or later than that of others, according to specific or even individual requirements. From this we must infer that Migration did not have a simultaneous origin; some species probably remained stationary ages after others had acquired the habit, gradually acquiring it as the causes became more intensified. Broadly speaking, it is birds that subsist on an insectivorous or an animal diet that are the greatest and most regular migrants, and they would be the first to acquire the habit. But even from the great variety of their food many would be compelled to adopt migratory habits before the others. Birds subsisting on a vegetable diet would persist in their sedentary habits the longest, and remain resident so long as their food was not buried in the snow. Many ages, however, must have elapsed between the period when the winters became too severe for insect life to remain active, and the ages when

animal food might be picked up on the Arctic coasts; or again, the ages when winter had become so severe that all the land was buried deep in snow, and the ocean itself sealed with ice. These varying details, however, do not prevent us from going back to a remote past, when probably the birds inhabiting temperate and even northern regions were sedentary. That this was probably the case in Eocene times is reflected in the fact of the wondrous wealth of vegetation, indicating a corresponding high degree of temperature then prevailing, when palms clothed the English plains, when crocodiles basked in the rivers, and a glorious sub-tropical climate reigned supreme. Or even more recently in Miocene ages, when chestnuts and magnolias, walnuts and vines flourished in Greenland, and the swamp-cypress and the water-lily grew on now desolate and ice-doomed Spitzbergen—when the Lower Miocene climate of Switzerland, for instance, resembled that of North Africa to-day. To understand the subject clearly, it will now be necessary briefly to review the changes which have undoubtedly occurred during this remote past of Tertiary time, and of which we have abundant geological and palæontological evidence, and which are still further confirmed by astronomical calculation.

From Dr. Croll's published tables (*Philosophical Magazine*, xxxvi. 1868), showing the amount of the Earth's eccentricity of orbit for the past three million years, it appears that a long-continued period of exceptionally high eccentricity occurred

little less than 2,000,000 years ago, and another about 850,000 years ago, which probably correspond in time with the Eocene and Miocene Periods respectively. Owing to the physical aspect of the great masses of continental land during these ages being such as to admit not one but several warm ocean currents into the Polar area, the differences of climate produced by precession and these great changes of eccentricity would not be very marked. As Wallace remarks: "the summers would be at one period almost tropical, at the other of a more mild and uniform temperate character; while the winters would be at one time somewhat longer and colder, but never probably more severe than they are now in the West of Scotland." Gradually through the Pliocene Period the eccentricity of the earth's orbit again became exceptionally high, and finally culminated in the Post-Pliocene Glacial Epoch which was brought about by this and other causes, already noted. It will thus be seen that although the climate never became glacial during the Tertiary Period, great changes took place, perhaps not sufficiently severe to lead to a very decided Migration of birds, but enough to initiate the habit in a comparatively small degree.

That the Glacial Epoch had an incomparably deeper and more lasting effect upon the movements of birds than any other climatic change during Avian history, is unquestionable. As this grand phenomenon progressed, rendering the climate of the Polar and temperate zones more and more rigorous, the

Migrations of birds became increasingly pronounced, and its culminating point was reached when the North Polar world became covered with a vast icy mantle, and all living things were either killed or banished to more southern latitudes. During the initial stages of the Glacial Epoch, when eccentricity was not so high as at a later phase, alternations of warm and cold periods were caused by winter occurring in perihelion or aphelion. But as long as eccentricity remained high and at its climax, precession had little effect upon the glaciated Pole, and only a partial amelioration of climate took place during the inter-glacial periods in more southern regions. When eccentricity was considerably diminished precession had again a more marked effect upon the climate, and a warmer temperature prevailed than is now the case. Since the passing away of the Glacial Epoch the eccentricity of the earth's orbit rapidly decreased, and for the past 60,000 years it has remained uniformly low, with this inevitable consequence, that the changes of climate produced by precession have been correspondingly slight, and the climate of the north temperate zone has remained in an exceptional state of stability. One inevitable result of the Glacial Epoch was to place Migration on a very different basis from what it had occupied before. All the Præ-Pliocene order of things had passed away; continents had become more closely knit together; seas had vanished; archipelagoes disappeared; warm currents had been diverted and checked; Polar land elevated.

Now I think from the above evidence we may safely come to the conclusion that vast changes of climate have taken place at irregular intervals, not only throughout Tertiary time, but during the entire progress of the Glacial Epoch in the northern hemisphere. Warm tropical climates have prevailed; cold climates have succeeded them; the Polar area has been peopled with a rich fauna and flora (birds of course included); and just as surely has it been devastated and become the habitude of icy desolation, entailing the utter banishment of life. We have thus seen that the Glacial Epoch was not a primary cause of Migration; rather has it been a colossal agent of emigration and of banishment; for many of the avian forms then driven from their Polar homes never returned, but were the founders of innumerable colonies in more southern latitudes. In this banishment many new forms had their origin through Variation, preserved by Isolation and Natural Selection.

It now becomes necessary to show what effect local glaciation may have had on the vertical Migration of birds. There can be little doubt that during the Tertiary Period many birds although resident in the Northern Hemisphere retired from the lowlands to the mountains to breed, or were even residents on such lofty ranges as occurred within this area. Now it seems probable that during phases of high eccentricity, in Miocene ages, for instance, much local glaciation occurred in the Alps, in Scandinavia, the Pyrenees, the Caucasus,

the Himalayas, and elsewhere, wherever great extents of high land offered favourable conditions to its initiation. From these localities all living things were driven down the hillsides by the advancing glaciers; although on the lowlands and in the Polar area, where no vast masses of elevated land occurred, and where other geographical conditions were favourable, such a phase of high eccentricity produced little change, and these areas remained in the enjoyment of an uninterrupted climate of a warm character. This local glaciation would have the effect of slowly compelling resident birds to adopt migratory habits, or cause considerable emigration amongst them; and it is conceivable how birds that visited the uplands every summer gradually modified their movements in various ways to adapt themselves to the changing aspect of their breeding areas. As these glaciers once more retreated, migratory movement would again be excited in many directions; and one can imagine how birds after becoming residents on the lower grounds, renewed their seasonal visits, or even emigrated on a large scale to the haunts their ancestors held in past ages. Even during such periods of low eccentricity as prevail at the present day, the influence of precession on the snow-line of mountains would be considerable, and its results on the movements of birds important.

A few words now on the probable future of Migration. That it will undergo many important changes during the next precession of the equinoxes is as

certain as that that grand revolution of the seasons has produced changes in the past. At the present time the northern temperate zone with winter in perihelion combined with a low degree of eccentricity is favoured with a comparatively mild climate, and this, in the normal course of things, will be enjoyed for some thousands of years. Then, however, with winter in aphelion, a colder climate will undoubtedly prevail; the winters will become colder, and last longer; the summers become hotter, and shorter in proportion. These changes would so modify the present climate of the British Islands that, as Wallace suggests, perpetual snow will rest on all our highest mountains. The effect of such an inevitable change of climate will be to banish many of the birds from our islands during winter that are at present resident with us, to cause many other migrants to alter the period of their annual journeys, and to lower the winter range of many boreal forms that at the present time winter in latitudes north of us. This descent of northern forms and banishment of species to southern haunts will also entail many movements among species wintering in them, through changed conditions of life due to competition, and consequently a fiercer struggle for existence.

It has been suggested by Mr. Seebohm that the migratory habits of the birds comprising the great Polar family CHARADRIIDÆ were initiated by the want of light during the North Polar winter (or the season analogous to such, for no great change of temperature then occurred to separate that period

so acutely from summer as now), when all was in perpetual star-lit gloom, even during the prevalence of mild climatal conditions. But I think the selection is singularly an unhappy one as an example of this cause of Migration. It seems to me that the want of light necessitated the habit of feeding during darkness—a habit which is notoriously continued to the present day, even by preference, by many of the Waders and Ducks, probably the birds last to linger in the Polar basin at the commencement of the Glacial Epoch. Now the one great dominating impulse to Migration is undoubtedly the want of food. Whatever influenced this supply, either directly by destroying it altogether, or indirectly by rendering its capture a more difficult or even impossible proceeding, would have an irresistible tendency to cause migratory habits to be adopted. Polar darkness would have a direct influence on insect life in two ways. Either it would cause these creatures to retreat for the period of its continuance, or render them partially nocturnal for the like time. Of the two, the latter seems to me the most likely. It therefore follows as a natural consequence that the birds living on insects would either have to retreat south beyond the limits of Arctic darkness, to where light prevailed for a sufficient time each day to enable them to find sufficient food; or, in the event of insects becoming nocturnal, to so modify their own habits as to become nocturnal themselves. That the Waders adopted the latter course seems proved

by their strong addiction to nocturnal feeding now, notwithstanding the fact that their food (mollusks, crustaceans, worms, and insects) may now as then be obtained at all hours of the twenty-four. Of course during spring and autumn they would be open to the necessity or the inclination perhaps of feeding by daylight as well as by night, whilst in summer their nocturnal habits would be lost in eternal day. Darkness would have little or no effect on seed-eating birds, for their food supply would receive no modification, and be as accessible in the dark as in the light. Besides, these birds then as now did not probably range into such high latitudes as to be subject to the influence of Polar darkness; they doubtless dwelt in lower latitudes where the day in winter would be short, but sufficient for their requirements; and this fact is confirmed in what I believe to be a very startling way by the habit of all seed-eating birds rising late and retiring early—*with the sun, in fact*—even at the present day. A tendency to nocturnal habits is the rule rather than the exception among all northern and insectivorous birds. The water birds are notoriously as much at ease either by day or by night in their quest for food. It is also a most remarkable fact that a very high percentage of Arctic insectivorous Passerine birds show a decided partiality for *feeding at dusk*. Habits like these are neither acquired without cause nor readily relinquished. The Redwing (*Turdus iliacus*), the Fieldfare (*Turdus pilaris*), and the Arctic Bluethroat (*Erithacus suecica*) are all birds

breeding at or above the Arctic Circle (and doubtless bred much farther north during milder climatic conditions), and still possess the habit of feeding far into the twilight. This, I consider, seems to imply that they or their ancestors (for the habit widely prevails throughout the TURDIDÆ) continued to inhabit the northern world during the Polar night, so long as climatal conditions permitted a constant residence in these regions both of themselves and the various creatures on which they fed. That want of light may have been an initiating cause of Migration is not altogether improbable; but a gradually lowering temperature was undoubtedly the most potent, and as applied to the Waders and the Ducks the only cause.

It has been laid down as an axiom in Ornithology that the birds that go the furthest north to breed go the furthest south to winter; but the vast importance of this fact as bearing on the past history of Migration appears hitherto to have escaped notice. It is an interesting fact in itself, but to my mind the cause of the habit is immeasurably more interesting, indicating, I would suggest, an Ancient Migration extending almost from Pole to Pole. That the Antarctic continent (a circular mass of land more than twice the area of Australia) during remote ages has from time to time enjoyed periods of climate mild enough to support a fauna and flora as rich as or even much richer than those now peculiar to Arctic lands, seems indisputable. The botanical evidence is certainly in favour of

such conditions having prevailed in past ages; there is much evidence that the centre of dispersal of many groups of birds is Antarctic.

Now it is a remarkable and suggestive fact that among the CHARADRIIDÆ the species breeding in what we may well describe as the North Polar Basin have the longest migrations of any known birds. The following half-dozen species are among the most Arctic of birds. First we may instance the Sanderling (*Calidris arenaria*), breeding in the North Polar Basin, and extending its winter migrations southwards to the Malay Archipelago, the Cape Colony, and Patagonia; second, the Turnstone (*Strepsilas interpres*), whose breeding range is circumpolar, and extends into the Arctic regions, whilst its winter range touches pretty well every extensive coast-line south of the Tropic of Cancer; third, the Curlew Sandpiper (*Tringa subarquata*), which breeds on the highest North Polar land, and extends its winter flights as far as Australia; fourth, the Knot (*Tringa canutus*), which breeds within the narrow compass of the North Polar Basin, and in winter wanders to Australia, New Zealand, Cape Colony, and Brazil; fifth, Bonaparte's Sandpiper (*Tringa bonaparti*), which breeds in Arctic America, and in winter reaches Patagonia and the Falkland Islands; sixth, the Red-throated Stint (*Tringa ruficollis*), breeding in North-eastern Siberia, but how far north is not precisely known, and in winter extending its southern flight to Australia. Two of these species

(*Calidris arenaria* and *Tringa bonaparti*) are even reputed to have bred in the southern hemisphere, the former as far south as Lord Howe's Island, and the latter in the Falkland Islands, which, if true, strongly confirms a previous Antarctic habitat. At least twenty species of Charadriinæ birds from the Arctic regions visit Australia during winter; as many more probably reach South Africa and South America at that season, in addition to the sedentary species.

One may very naturally ask the reason for these vast extended flights.[1] Why are they undertaken for no object that man can determine? Migration is by no means a habit subject to caprice; nor do birds ever undertake it either in space or time without serious cause. I am of opinion that these long journeys, some of them reaching over 140 degrees of latitude, or nearly 10,000 miles direct, are the result of the transfer of these species from the North Polar Basin to the South Polar Basin,

[1] The suggestion made by Mr. Harvie-Brown (*Report, Migration of Birds*, iv. p. 71), that it is owing to the hardiness of constitution of birds bred in high Arctic latitudes that their fly-lines are so extended; and also to the annual overflow of enormous numbers pressing from behind and urging on to the south those in the van, needs little to refute it. The Knot (*Tringa canutus*) is given as an instance. Unfortunately for this ingenious theory, the Knot is bred in a high temperature, just in the very height of the short Arctic summer, and begins to draw south as soon as it can fly. It has, therefore, at no period of its existence any experience of the rigours of an Arctic climate; but, on the other hand, lives almost in perpetual summer or spring. Strength of constitution seems to have no effect whatever on the length of migration flight; the influences are of a far more deeply-rooted character.

during favourable intervals of climate. These birds extend their flight towards that ancient Antarctic habitat as far as they can find land free from snow on which to rest, impelled by hereditary impulse and inherited love of home. In those remote ages, when the Antarctic world was the favourite ancestral breeding-grounds, and the Northern Hemisphere their winter home, the flights would be just as extended as they are now. Birds are conservative creatures, and continue to follow old routes with much persistence, as we shall ultimately find. Of course we should only expect to find comparatively few birds doing this; and for many obvious reasons, most important of which is the small percentage of birds whose habitat is strictly Polar, and the vast remoteness of the time since Antarctic land was habitable; for the evidence is decidedly in favour of a very long-continued state of glaciation, owing probably to the absence of warm ocean currents and the presence of considerable areas of very elevated land. Consequently, the majority of species have been able slowly to adapt themselves to the conditions which render such extended flights unnecessary, or many others may have bred in lower latitudes of the Northern Hemisphere which did not suffer so much acute change of climate. For the sake of argument, these Polar birds of extended Migrations breed in the Northern Hemisphere, and winter in the Southern Hemisphere; although it must be understood that many individuals have ceased to perform the journey in its

fullest extent, but winter in various parts of the Northern Hemisphere, where climatal conditions are suitable.

Now if this were actually the state of things during remote ages when the South Polar Basin was a great breeding-ground for Waders and other birds, it is only reasonable to expect that some evidence is still left to us in support of our conjecture. Such evidence fortunately is forthcoming. There are many species of the CHARADRIIDÆ left behind in the Southern Hemisphere, remnants of that Great Exodus of byegone ages, some of them very ancient relics indeed, as, for instance, the three species of *Phegornis*, one of which (*P. leucopterus*) is stranded on the Society Islands; another (*P. cancellatus*) on the Paumota Archipelago, and the third (*P. mitchelli*) on the Peruvian Andes. These birds are remarkable for their rounded wings, sedentary habits, and other peculiarities, and are acknowledged by one of the greatest living authorities on this group, Mr. Seebohm himself, to be "the least changed descendants of the ancestors of the Sandpipers." Their presence on these Pacific Islands and coast of South America appears to me to indicate an ancient route of Migration across the Pacific Ocean in the extreme east and west, from one Polar region to another—a route which now is to a very great extent discarded by existing species, although even at the present day there is a considerable Migration across that ocean by way of the Malay Archipelago and Australia. For, just as the line of present

Migration may in many cases indicate the direction of past Emigration, so may the present centres of Emigration denote ancient paths of Migration. More ancient evidence still of species stranded during Inter-Polar Migration may be found among the CHIONIDÆ and the THINOCORIDÆ, composed of aberrant species of CHARADRIIDÆ, isolated on various parts of the borders of the Antarctic Ocean.

Mr. Seebohm has very elaborately sought to show that the CHARADRIIDÆ is a North Polar group of birds, and seeks to explain the presence of some of these undoubted ancient forms as due to an exodus from the Arctic regions during glacial disturbance; but these isolated species seem to me to indicate South Polar origin; for it is only natural to expect to find the least changed ancestral forms nearest to the centre of dispersal, and this we certainly do not find in the northern hemisphere. Just as the Arctic ALCIDÆ have their more ancient prototypes, the Antarctic IMPENNES, indicating a remote Inter-Polar Emigration, so it appears to me the birds forming the groups CHIONIDÆ and THINOCORIDÆ indicate a South Polar dispersal of the CHARADRIIDÆ, and a less remote Inter-Polar Migration. There is other evidence to show that many Charadriinæ birds are decidedly more Antarctic than Arctic in their dispersal—not northern species at all, but eminently southern, such as the Stilts (*Himantopus*), the Oystercatchers (*Hæmatopus*), and the Lapwings (*Vanellus*).

The same ornithologist's Glacial Theory of Dis-

persal applied to the CHARADRIIDÆ,[1] is not supported by geological evidence. First, no less than three glaciations of the North Polar region are required to account for the present dispersal and differentiation of this family of birds into genera and species. But the evidence of more than one North Polar glaciation during Tertiary time is absolutely wanting; all that can be gleaned points to one Glaciation only, which, as we have already seen, was Post Pliocene. Secondly, the dominant line of Migration of these birds is unquestionably Inter-Polar, which forces us to the inevitable conclusion that the ancestral forms of this group of birds during remote ages peopled a South Polar area. Another fact strongly confirming Inter-Polar migration is the comparatively cool temperature which appears to be imperatively necessary for the majority of these birds during the breeding season. It seems hard to believe that such Polar birds could ever become so thoroughly acclimatized to tropical zones as to remain isolated in them for thousands of years, as this Glacial theory of dispersal demands, when an Antarctic Polar haunt was open to them, especially as we know that as soon as the North Polar regions became once more habitable a great exodus to them commenced, probably as South Polar haunts became glaciated. Again, it appears to me that too much reliance is placed on the various reputed routes, along which species are said to have

[1] Obviously suggested by *Evolution without Natural Selection*, chap. I. (published in 1885).

emigrated at the close of the Pliocene age. There is much evidence to show that the following of these routes was highly improbable, if not impossible, simply because the land area of the north temperate zone has undergone vast change during Tertiary time, and must have had a very different aspect from what it now presents.

Let us now turn to more recent testimony. In the Falkland Islands *Charadrius modestus* breeds, and goes north to winter as far as Uruguay; whilst an allied form, *C. modestus rubecola*, breeds on Tierra del Fuego, and passes as far north as Chili during winter. The fact that this species has become segregated into two races in so narrow an area seems to suggest a long residence in this region. In the same group of islands we also have, in Tierra del Fuego, *Charadrius sociabilis*, with the same distribution as *C. modestus*, and *Scolopax frenata magellanica*, breeding in the Falklands, and passing as far north as Paraguay to winter. In Chili we find *Himantopus brasiliensis*, with a considerable northern migration during winter; also *Rhynchæa semicollaris*, which in summer extends its range south to Magellan, and in winter north to Brazil. In fact, all the species of the genus *Rhynchæa* appear to me to be decidedly Antarctic. Their present distribution seems to admit of no other conclusion. Their presence in Patagonia, South Africa, Australia, and India (probably by way of the Malay Archipelago, Siam, Burma, and Lemuria), rather shows an Antarctic emigration than

a centre of dispersal in India, due to Post-Pliocene Arctic emigration, which spread by no conceivable way to South America! In the Snares and Chatham Isles *Scolopax auklandica* is a resident; in New Zealand we find *Ægialitis nova zelandiæ*, and *Charadrius obscurus*, the latter breeding on the mountains and wintering on the plains; whilst in Australia *Charadrius australis* may be given as an instance. Now, I think, after having seen that some species even at the present day migrate across the world from north to south, that others are isolated and sedentary in the Southern Hemisphere, having allowed their migratory impulses to lapse altogether, whilst others yet again breed as far to the south in the Southern Hemisphere as suitable land occurs, and pass north to winter, we are driven to the conclusion that Inter-Polar Migration amongst the CHARADRIIDÆ must have extensively prevailed in remote ages. It should also be remarked that none of these birds pass north of the Equator to winter—a fact which in itself seems to suggest a South Polar origin, whilst the number of Arctic species that winter south of the Equator is very considerable, and seems to show a lingering attachment to an ancient home.

Much evidence might also be given to show that the ANATIDÆ, or Ducks, and a portion at least of the Turdinæ (*Merula* and *Turdus*, or their common ancestors), have in past ages been Inter-Polar likewise. The HIRUNDINIDÆ, or Swallows, seem to be an Antarctic group which have comparatively recently become almost Inter-Polar in their migra-

tions, and would undoubtedly become entirely so if milder climates again prevailed in North Polar regions. We should then find many species of this group inhabiting an Arctic area, with other species left behind in southern latitudes, just as we find to be the case with the CHARADRIIDÆ and the ANATIDÆ at the present time. North Polar conditions are now sufficiently favourable to allow great numbers of Waders and Ducks to visit the Arctic regions, although not sufficiently so for many species of Swallows to visit them, and as a natural consequence the latter birds are still the most abundant in the Southern Hemisphere, whilst the former birds predominate in the Northern Hemisphere. One thing appears to be remarkable about the migration of these Southern Hemisphere species, and that is their comparative shortness. This appears due to the very low southern breeding area. Undoubtedly in the event of the South Polar region once more becoming free from ice, the migratory flights of these birds would be gradually extended south, until they equalled in length those of their Arctic allies. Inversely, we can understand the migrations of Arctic species gradually becoming shorter as glaciation sealed their Polar haunts; culminating probably in a grand emigration of many northern species to Antarctic regions, as we have been endeavouring to demonstrate has actually been the case in past ages.

In the preceding pages of this chapter I have sought to impress upon the reader the fact that

Climatal Change, if it has been enormous and severe, has been gradual. We should naturally expect to find therefore the result of this reflected in present Migration. This is undoubtedly the case; for Migration is gradated in many various degrees both of space and time. It is by no means universally extended among species, or even, as we have already seen, among individuals of the same species (*conf.* p. 20). The flights were short at first, and were very gradually extended; varied likewise as to time and performance, as the seasons became shorter or longer. The evidence for this is abundant, convincing, and indisputable. The irregular appearance of many northern species in such southern latitudes as the British Islands, during exceptionally severe winters, admirably illustrates how under more pronounced conditions of persistent cold, Migration could be initiated. It is easy to understand how, if the winters were gradually to become uniformly and constantly more and more severe, these species, instead of paying only occasional and irregular visits south, would in the course of ages become regular migrants; and the habit or impulse to migrate, owing to the laws of heredity and a continual climatal cause, would become finally a deeply-rooted one. There can be no doubt whatever that this is very similar to what has actually taken place, not only throughout the varying climates of Præ-Pliocene ages, but during the lowering temperature of the Pliocene period itself, which, according to Professor Marcou and other scientists, was actually

the beginning of the Glacial Epoch; and yet again whilst that epoch was slowly pursuing its terribly majestic course along 200,000 years of time, with alternating mild periods at its inception and its close. We may instance among many others the Gray Phalarope (*Phalaropus fulicarius*), Ross's Gull (*Rhodostethia rossi*), the Glaucous Gull (*Glaucus glaucus*), the Iceland Gull (*Glaucus leucopterus*), the Little Auk (*Mergulus alle*), the Harlequin Duck (*Clangula histrionica*), Steller's Eider (*Somateria stelleri*), and the King Eider (*Somateria spectabilis*). Now all these species are either Polar or Arctic in their distribution, more or less stationary (in the sense of having but a slightly marked southern flight in winter), and only appear very irregularly in localities far south of their usual habitat, and then only when exceptionally severe winters in the north compel a southern movement. None of these birds remain long in the south; they retire as soon as milder conditions prevail, and their movements although migratory are irregular and uncertain. They are examples of what may be termed Incipient Migration. Whenever climatal conditions become more severe, entailing absence of food, regular and more extended flights may become the rule among at least some of these species. We shall refer more particularly to this matter in a future chapter.

From species whose migratory movements are at the present time incipient, we will now pass to others in which they are decidedly regular, though small. Excellent examples of short migration flight

are presented in such species as the Rufous Warbler (*Sylvia galactodes*), the Woodchat Shrike (*Lanius rufus*), the Woodcock (*Scolopax rusticola*), and the Golden-eye (*Clangula glaucion*). Moderate journeys are represented by the Great Reed Warbler (*Acrocephalus turdoides*), the Turtle Dove (*Turtur auritus*), the Crane (*Grus communis*), the Jack Snipe (*Scolopax gallinula*), and the Mallard (*Anas boschas*). Amongst birds whose migrations are decidedly long, we may note the Wheatear (*Saxicola œnanthe*), the Cuckoo (*Cuculus canorus*), the Corn Crake (*Crex pratensis*), and the Greenshank (*Totanus glottis*). The most extended flights of all known birds are performed by such birds as the three species of British Swallows (*Hirundo rustica*, *Chelidon urbica*, and *Cotyle riparia*), the Turnstone (*Strepsilas interpres*), the Gray Plover (*Charadrius helveticus*), the Sanderling (*Calidris arenaria*), the Knot (*Tringa canutus*), and the Pectoral Sandpiper (*Tringa pectoralis*). The following table will serve to demonstrate the gradated character of migration. The mileage is approximate, and represents a course almost due north and south; but few, if any species, however, travel so direct, so that the actual distance traversed may be in excess of the figures on the following page.

From the above facts I think that we may very fairly make the following deductions. First, that incipient and short migration flight indicate movements to correspond with comparatively small variations of climate necessary to requirements and

INCIPIENT	Waxwing Gray Phalarope Iceland Gull Ivory Gull Little Auk Steller's Eider	Mileage erratic; but normally from 1000 miles downwards
SHORT	Rufous Warbler Woodchat Shrike Pied Wagtail Stone Curlew Woodcock Black Tern Golden-eye	From 1000—2000 miles
MODERATE	Rock Thrush Great Reed Warbler Bee-Eater Turtle Dove Spoonbill Crane Lapwing Jack Snipe Mallard	From 3000—5000 miles
LONG	Wheatear Sedge Warbler Blue-headed Wagtail Nightjar Cuckoo Corn Crake Greenshank	From 6000—7000 miles
EXTENDED	Swallows Turnstone Gray Plover Whimbrel Knot Pectoral Sandpiper Sanderling Curlew Sandpiper Asiatic Golden Plover Hudsonian Godwit	From 7000—10,000 miles

consequent supply of food, together with gradual extension of range longitudinally, not essentially dependent on climate, and that these movements are the most recent in geological time. Second, that moderate and long migration flight are the result of a gradual extension of summer range, chiefly latitudinally, owing to modification of climate, with consequent increase of individuals, leading to an expanse of winter area, and are of much older initiation. Third, that extended migration flight implies a complete change of breeding-ground, more or less Inter-Polar, and is decidedly the most ancient of all.

In the present chapter we have glanced at the probable origin and descent of Birds; at the changes of climate they have experienced from the date of their evolution from a lower form; endeavoured to show how these changes have been brought about, and what the result has been. We have glanced at some of the most powerful causes of Migration, and traced the wonderful gradations of Migration Flight to their origin both in their mildest and in their acutest phases. We will now conclude by following in detail the migration of some single species, say from its Post-Pliocene glacial initiation to the present day, in order clearly to demonstrate Why the habit has been acquired, and How it is practised.

We will select the Spotted Flycatcher (*Muscicapa grisola*) for the purpose. It is one of our best known summer migrants, and one whose present

geographical distribution admirably illustrates the phenomenon of Migration. When the Sub-Polar regions of the Northern Hemisphere last enjoyed a warm, almost semi-tropical climate—one of the mild periods of the Glacial Epoch—the Spotted Flycatcher inhabited in one unbroken area the Arctic woodlands from the Atlantic to the Pacific. Probably it was a resident species becoming partially nocturnal during the Polar night; food was abundant; its conditions of life were easy, and it multiplied apace, and became a dominant, firmly established species during the thousands of years that it dwelt in this Sub-Polar habitat. So matters continued until the slow precession of the equinoxes, in conjunction with increasing eccentricity of the earth's orbit, began to have a marked influence on the climate, and gradually the fair forests and the verdant plains were devastated by the ever-increasing cold. Age after age the Spotted Flycatcher was driven slowly south; summer after summer grew colder and shorter, the periods of Polar darkness more severe. At last matters became so serious that the birds began to leave their northern haunts in autumn, probably because their food became scarce as the various insects either retreated south or began to hibernate. Further and further southward these annual journeys had to be taken, until the Flycatcher at last found its way during winter into Africa, Persia, Arabia, India, China, and even the Philippines and the Moluccas. Summer after summer the belt of breeding-ground became wider and wider, and vast numbers of individuals became

separated from the rest of the species by the lofty mountain ranges, the deserts, and other physical barriers, which would effectually arrest a forest or woodland haunting species. More and more severe became the winters, longer and longer; the glaciers descended lower and lower, exterminating or driving before them all living things. At last the Spotted Flycatcher, or the form which then represented this species, came to be divided into two enormous colonies—an African one and a Chinese one—the individuals of each being completely isolated from each other, summer and winter alike. During the ages that this state of things continued, the Flycatchers became segregated into two species, owing primarily to the absence of any intermarriage; the eastern race became smaller, the tail shorter, and the breast-streaks broader; or the western race became larger, with a longer tail and narrow breast-streaks. It is almost impossible to say which form now most closely resembles the ancestral species, but such are the present differences between the two races known to ornithologists respectively as *Muscicapa grisola* (the Western and British form) and *Muscicapa griseisticta* (the Eastern form). Such was the state of things at the close of this Inter-Glacial Period.

Then came the gradual immigration north again as precession and lower eccentricity initiated a milder climate. Age after age the journey in the spring became longer. Certain routes to and fro became to be recognized highways of passage; and so imperceptibly did the northern breeding-grounds expand, that the birds became regular migrants,

looking upon the movement north to higher and cooler latitudes each spring as an undertaking never to be missed. Warmer and warmer became the southern haunts, stimulating and widening migration flight to the cooler temperatures prevailing near the edges of the retreating glaciers, where a suitable breeding climate could only be found.

Let us confine our attention solely to the birds that bred in the British Islands. In the Præ-Glacial ages this area formed part of Continental Europe; a rich and fertile corner, abounding in insect life, full of haunts the Flycatcher loved. After the banishment of its race and the exile of its ancestors in Africa, the northern journey at first did not extend further than the edges of the glaciers on the Mediterranean coasts of Europe. But as these disappeared, and a warmer climate began to prevail in higher latitudes, the annual summer flight was increased. Every century the northern breeding range had increased; creeping slowly across France; higher and higher with the growing vegetation; nearer and nearer to the haunts of old. During the slow gradual elevation and submergence that isolated Albion from the rest of Europe during Post-Glacial time, the regular spring journey across the sea became wider and wider; but with the intense and inherited love of home in their tiny breasts, the individuals that were born and bred in this district never failed to return each year. For 60,000 years or more has this species now crossed the sea, returning every season, not only to our islands, but each pair of individuals as long as

they live come back to the exact locality of their previous nests. This long journey, gradually growing longer and longer during thousands of years, until it is now at least a thousand miles in length, has grown to be a deeply-rooted custom sanctioned by the practice of ages of experience and need, and looked upon now as part of the Flycatcher's very existence!

The above interesting and thoroughly demonstrable instance shows two very important ways in which Migration has been initiated. First, by a gradual movement south during a short winter, growing more extended in space as the climate became more severe, and more prolonged in time as the winters became longer. Second, a gradual movement north again with the return of milder climatal conditions. In both movements, however, the first journeys undertaken were probably of very small extent, and slowly became longer as the summer area of distribution became wider. During this period of Glaciation, bird-life was utterly banished from all northern and many temperate lands. During the past 60,000 years a general avian exodus has been in progress. All the hardier birds have emigrated back as far north as they can live, and many have become sedentary in the more temperate areas, but the winters still continue too long and too cold for the majority of insectivorous birds breeding in those areas, with the inevitable consequence that Migration among them is the almost universal rule.

CHAPTER III.

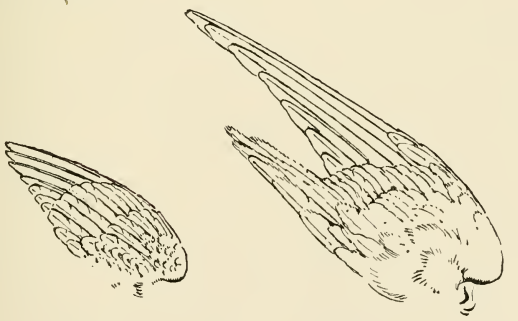
THE PHILOSOPHY OF MIGRATION.

Wings of Migratory Birds—Plumage of Migratory Birds—Moulting—Order of Migration in Autumn—*Avant-Courières*—Migration of Young Birds before Parents—Order of Migration of Adults—Order of Migration in Spring—Time of Migration Flight—Punctuality of Migrants—Amount of Sociability and Gregariousness in Migrants—Weather-bound Migrants—Duration and Progress of Migration—Speed of Migration Flight—Rapid Flight of Dotterel in Spring—Altitude of Migration Flight—Influence of Bright Lights on Migrating Birds—Migrants at Lighthouses and Light-ships—Effects of Reflected Light—Advantages derived from Lofty Flight—Possible Use of the Balloon in studying Migration—Cries of Birds on Passage—Effects of Wind on Migration—Influence of Temperature on Migrating Birds.

The two preceding chapters have been primarily devoted to the biography, antiquity, and origin of migration; it now becomes necessary to deal with the actual phenomenon itself. We have seen when and how migration had its origin, now let us trace the various conditions under which it is practised. Flights of such enormous magnitude are not lightly undertaken, and many things have to be considered during their progress. Even before they are commenced certain preparations have to be made, and many, and varied, and complex are the influences inseparably associated with these wonderful journeys.

In the first place birds must be in good condition before their long pilgrimage can be undertaken with any degree of comfort or hope of success. A flight of many thousands of miles requires much physical exertion; the fatigues of such a long journey can only be undergone with success, and the perils reduced to a minimum, by birds capable of performing the distance in a reasonable time, and withstanding the enormous constitutional strain. It is a rule almost without exception that the wings of migratory birds are long and pointed —a form best adapted not only for sustained but rapid flight. It may also be remarked that the birds which cover the longest distances have the most pointed wings. The Turnstone, with its enormous migration flight of ten thousand miles or more, has a long pointed wing, the first primary being the longest, and this is the rule throughout the CHARADRIIDÆ, the only exceptions being of species whose flights are very short or dispensed with altogether, as in *Phegornis:* the Swallow's wings are equally pointed. The laws of use and disuse determine the shape of the wing of a bird. The wings of a bird vary according to the amount of flight indulged in by their owner. Birds that fly much have pointed wings; birds that fly little have short and rounded wings; whilst birds that rarely fly at all eventually degrade into species utterly incapable of flight, as was the case with the now extinct Great Auk, and is the case with the still existing Antarctic Penguins. Long pointed wings,

however, do not necessarily indicate migratory habits, for many sedentary birds possess them; but these species, as for instance many of the Raptores, some of the Terns, many Humming Birds, and many Swallows, all depend largely on their wings for obtaining food. Let us glance at a few instances. The wings of a Goldcrest or a Willow Wren are long, flat, and pointed, best adapted in every way for migration flight; but the wings of a Wren or of a Dipper are short, more concave, and rounded, a shape most ill-adapted for long-sustained flight. All, or nearly all, the TIMELIIDÆ, most of the PITTIDÆ, many of the PARADISEIDÆ, and hosts of other sedentary tropical Passeriformes are remarkable for their feeble, concave, short and rounded wings.



DIPPER'S WING (Sedentary). TURNSTONE'S WING (Migratory).

This variability not only extends to the feathers of the wing, but includes corresponding development of the bones which support it and the muscles with which it is worked. That the shape of the

wing is correlated with the habits of the bird is very significantly proved by the fact that in Arctic and temperate regions where migration is most practised, there are few birds with the short rounded concave wings of the sedentary birds of the Tropics, where migration is little practised. It should also be stated that the plumage of migratory birds is generally close and compact; a loose and fluffy dermal covering is seldom worn by any but the most sedentary birds. We may thus fairly begin with the fact that birds of passage are both in the formation of the wing and in the texture of their plumage the best of all birds adapted for flight.

We will now advance a step further in our subject. The feathers of a bird are renewed—in other words moulted—as every naturalist knows, at stated periods. These periods vary a good deal according to circumstances, the only one of which we need stay to discuss being the period which seems correlated with migration. In many migratory birds, certainly in all those whose flights are the most extended (as in the CHARADRIIDÆ), a complete double moult takes place, in spring and in autumn. In all others a change is undergone in autumn, with the exception of the birds comprising the LANIIDÆ (Shrikes) and the HIRUNDINIDÆ (Swallows), in which the plumage is renewed in early spring. These latter exceptions may be easily explained. The birds in both these families appear to belong to the Southern Hemisphere, and have only within comparatively recent times extended

the area of their distribution northwards, so that their moult which is performed (by the Swallows) in February and March is really normal, that season being the autumn of the Antipodes. The more northerly dispersed Shrikes moult later, in our spring in fact; but this is only the retention of an autumn moult performed during bygone ages in their ancient southern home. The great majority of migratory birds therefore moult before they migrate, either in spring, or in spring and autumn; but some few, as, for instance, the Common Sandpiper (*Totanus hypoleucus*), moult in autumn in their winter quarters just after their migration is over, although in spring the change occurs before passage, as some sort of compensation for the irregular circumstance. No bird of single moult ever migrates in autumn before changing its flight-feathers, and the change is effected just previous to the journey. Normally, and almost without exception, the moult of the quills, whether single or double, comes to an end just before the time of actual migration arrives; although some birds, as, for instance, several species of Geese (*Anser*), begin to walk from inland breeding-places *en route* to the coast or great river valleys, changing their dress as they go, whilst others frequently moult many small body-feathers as they migrate. It must, however, be borne in mind that the change of quills is completed before the actual flight portion of the bird's migration is commenced. During the period of moulting, birds keep very close to their

haunts; they are songless, almost silent, skulk low in the cover, or, as is the case with aquatic birds, repair to the sea and open waters where the greatest amount of safety is to be found. They are well aware of their helplessness, and consequently keep very close and quiet. But by the time the new dress and the bright clean shaft-feathers have been acquired, which give them a new lease of aerial existence, migratory birds change their habits considerably. The hereditary impulse to migrate grows stronger and stronger within them, an impulse whose principles must be obeyed as inevitably as the impulse of sexual passion, and, well equipped with a new covering of feathers and a new set of flight-quills, the journey is commenced.

It must not be supposed, however, that all individuals start off together; the order of precedence appears to be observed with as much jealous strictness as at the courts of human kings and princes. The Order in which the individuals of a species migrate is influenced to a very great extent by the progress of the moult, especially in autumn. The quickening impulse to migrate in autumn is for a time at least subservient to the parental love of offspring; although as it reaches its highest stage of development it appears even to become stronger than parental love. Witness the Swallows and Swifts deserting occasionally late broods in autumn; leaving them in their nests helpless and to starve. Only last autumn (1891) I knew of a brood of three young Barn Swallows

left behind by their parents to perish, after lingering by them until the early days of November, when they were almost able to take care of themselves! But with birds that from some cause or another have not been able to breed, or have accidentally lost their eggs or young broods, no parental instinct exerts any restraining influence, and the desire to migrate often becomes so prematurely strong that they begin to leave their summer quarters in some cases even before their moult is absolutely completed. These birds are the pioneers—the *avant-courières* of the migrating army; the guides of the inexperienced, the heralds of the advancing host. Strange, impossible as it may seem, it is nevertheless true that the Young Birds—the birds that have never travelled before—are the next in order to migrate. In their case the impulse to migrate must be entirely hereditary, or nearly so; what little external influence incites them probably exists in the fact of seeing the *avant-courières* depart. These young birds are in the normal course of things the first to be in a position to migrate; they travel in their first plumage, and consequently are ready to go as soon as they can fly. That they do not tarry long at their birthplace after this time arrives is proved by the fact of their being seen in latitudes far to the south of where they were born a week or so after we know that their flight-feathers reached maturity. Again, young Knots (*Tringa canutus*) and young Gray Plovers (*Charadrius helveticus*), bred in some of the highest Polar dis-

tricts, are occasionally met with on the British coasts with particles of their downy nestling plumage still adhering to some of the feathers, after a flight of at least 2000 miles. It must not be supposed, however, that because the impulse to migrate is inherited from their parents, the *ability* to do so is equally hereditary. That has to be acquired; the road has to be pointed out by the more experienced guiding birds, and the long, often circuitous, route has to be *learnt* by the experience of not one but many annual journeys to and fro. Wonderful therefore as this order of migration is—and that it is a fact is proved by overwhelming testimony at every station where the passage of birds has been studied—there is nothing abnormal about the proceeding; and we see that the odd restless old birds that migrate before the rest, incite the young birds to start, and render the important service of showing those young and inexperienced the way. A week or so after the young birds have left, the adult males begin their migration, having got over the moult a little earlier than the females, the latter being delayed somewhat by maternal duties, so that their departure is a little later still. The rear of the great migrating army is brought up by the birds that from various causes have been either prevented from starting with the rest or delayed on the way, by such accidents as damaged flight-feathers or maimed and wounded limbs. Astonishing as this fact may be, it has been remarked and verified

repeatedly by Gätke whilst studying migration for half a century on the tiny island of Heligoland, one of the best adapted spots in all the world for the purpose. The order of return in the following spring is partially reversed. Then the adult males take precedence; the females travel next in order; the birds of the year follow these, and last, as usual, come the weakly and the wounded, following on in the wake of their more vigorous and healthy comrades, like so many camp-followers and disabled travellers in the rear of a marching army!

The daily time of migration flight varies a good deal. Some species more habitually migrate by day, and may frequently be watched on their journey north or south, as the case may be, all the time that the sun is above the horizon. The great majority of birds, however, migrate by night, or if they do pass by day, it is above the range of human vision. Many species, however, will continue their flight along certain routes after the sun has risen; yet, on the other hand, numbers prefer to rest for the day, provided they are on land, wherever they may chance to be, passing on again with the recurrence of darkness. Every observer of birds must have remarked these interesting facts over and over again. At sunset one day not a bird of a certain species can be found anywhere; at dawn the next the place may swarm with them. On the other hand, he may see a species abundantly one evening, and search for it in vain by daylight on the following morn. During spring and autumn, odd birds,

or little parties of birds, may be seen from time to time during the day flitting along; or suddenly a district may swarm with a species or even a number of species, which remain loafing about for the day, but not one will be left by the morrow.

The punctuality of arrival of birds either at their summer or winter quarters, or at various points *en route*, is nothing less than astonishing. Taking into account the length of the journey they have come, and the consequent number and variety of possible causes of delay, the best kept time of the crack expresses, or the passages of the fastest steamers that plough the ocean with a space-annihilating speed, absolutely suffers by comparison! A one hour late in the 200 miles' run of an express, or twenty-four in the 5000 miles' voyage of a steamer, is certainly, all things considered, a far worse record than the one day late in the 5000 miles, or the couple of days in 10,000 miles' flight of a bird, at the mercy of countless contingencies neither the train nor the boat have to battle with. And yet this is the simple statement of facts. Migratory birds may be looked for almost to the day, as any one can prove by keeping a record during a series of years. The arrival of sea birds at many of their breeding-places is so regular, that it forms a date in the calendar of men most concerned in the event. Of course, the date of arrival varies a good deal with different species. Some species migrate earlier, some later than others; the migration flight of each being regulated by various

influences more or less important, the chief of which is undoubtedly the supply of food. It is also worthy of remark that the birds migrating earliest generally stay the longest; whilst those that are the latest to arrive are the earliest to depart.

The amount of sociability in birds whilst on migration is not only very interesting, but very variable. Some species are solitary pilgrims indeed, coming and going in a very exclusive manner; if crowded together from some unusual cause *en route*, taking the first opportunity of separating again, even from the companionship of their own kindred. The Woodcock (*Scolopax rusticola*) may be instanced as a recluse; the Nightjar (*Caprimulgus europæus*) and the Cuckoo (*Cuculus canorus*) as others. Who has ever witnessed any gregarious or even social tendency in the migrations of these birds, always excepting the occasional crowds or "rushes" that are due entirely to accident, as we shall shortly learn? Other birds, however, are remarkably gregarious during migration, many species only becoming so at such a time, and even in species that are always gregarious the habit is more intensified during Flight. Other birds are not only gregarious but social also, and it is not unusual to find migrating flocks composed of parties of several species: witness the great congregations of the Swallow tribe, and of various Waders and Ducks at these periods. Many odd birds will also, from time to time, join a flock of some other and often very distantly related species, apparently for

the sake of company on the road. Other birds, especially those that pair for life, invariably migrate each in the company of its mate; and in such species as pair at their winter quarters, the vernal migration is always performed together, whether the individuals gather into flocks or not.

It very often happens during the course of the migration period, which, roughly speaking, lasts about three or four months in spring, and again in autumn, that a spell of bad weather, or the long persistence of unfavourable winds, will arrest the flight of migrants. Throughout the area of meteorological disturbance, Migration practically ceases for the time being. During the prevalence of unfavourable weather, however, great numbers of birds, sometimes of many different species, gradually accumulate, like so many wind- and tempest-bound vessels in a quiet bay, all delayed and waiting the first favourable moment to push on again. As soon as the weather changes the hosts of birds pass on; and it is to this cause we may chiefly attribute the spasmodic rushes of a species, or many species together, which so often occur, especially during the stormier and most unsettled months of the migration season. Owing to this, many eminently solitary birds are sometimes observed to arrive at a given point in company, but they invariably separate as the great influx spreads. These rushes are most frequent in autumn, not only because storms are more prevalent then, but because the number of migrants is greater than in spring.

The Migration of most, if not all, species may be roughly calculated at from one to two months each way, and has its regular phases of intensity. In some nomadic species it lasts much longer, as we shall learn in a future chapter. First, the migration of a species is marked by the advent or departure of a few stragglers, the most venturesome and restless individuals; then the flight becomes more vast until the culminating point is reached, perhaps in two marked rushes, after which it ebbs pretty much as gradually as it flowed. The phases of intensity are more marked and sharply defined in some species than in others, and are due probably to various local causes. It must not be supposed, however, that the period during which the migration of a species lasts, is actually taken up in direct flight. The time is taken up in draining the summer or winter area, and is longer or shorter according to the width of latitude cleared. Where the breeding area of a species extends over 3000 miles of latitude, with its consequent great variation of climate and date of season, the migration will be prolonged; birds starting from the most northern localities months before they do from the more southern ones. Where the breeding area of a species is narrow the migration is short, because most of the birds start at the same time. It is the same with the winter quarters. Where they extend far to the south they are filled more slowly than where they are restricted to narrower zones. The evidence that birds leave their summer or winter

quarters, and never stay until they reach their destinations, amounts practically to nothing, for the instances of continued flight are exceedingly rare. Birds travel by stages, staying here or there on the way to feed or rest, so that it is an extremely difficult matter to arrive at the rate of speed of the actual migration flight. That some birds can fly amazingly fast is unquestionable; that they habitually do so on migration is not supported by facts. The only stage of their journey which it is of vital importance for them to get over quickly, is that across the sea; some birds, however, have no sea to cross at all. Over land migrating birds appear to fly at a moderate speed and with great persistency, like a trained pedestrian who has set himself a long task of endurance, plodding along in a steady but continuous manner. We can only make the wildest guesses at the time occupied by individual birds in reaching their summer or winter quarters; consequently it is equally impossible to give a time-log of their route. Probably migrating birds do not average more than 300 miles per day, during their journey north or south; but certainly birds travel quicker north in spring than they do south in autumn. Of course, this does not adequately represent the velocity of their flight between the stages. Some birds can fly amazingly quick; Swifts probably can and do attain a speed of nearly 200 miles per hour. There is, however, one instance by which we can form some idea both of the rapidity of flight and the briefness of

migration time, if necessity demands a high rate of speed and a short time for transit. The Dotterel (*Eudromias morinellus*) breeds on the tundras of Arctic Euro-Asia, and winters in Africa, north of the Equator. Its spring migration is late and rapid, and as the bird is scarcely ever seen in intermediate localities during this season (Heligoland records but few in May), we are forced to the conclusion that this enormous flight of quite 2000 miles is performed without a rest, and between sunset and sunrise. If the Dotterel were to start in the evening gloom from its African haunts, say at seven, it would reach the moors of the Arctic regions, by flying 200 miles per hour, about five the following morning—a record of speed that makes the highest pace of our "Flying Scotchman," "Wild Irishman," or "Dutchman" appear but the creep of a snail by comparison, and of astounding endurance, which may well fill us with genuine admiration and wonder. As is usual, the flight is slower in autumn, and then the Dotterel is observed on passage in the ordinary way, crossing Heligoland in August, passing through Germany in September, and Malta in October and November, but always very rare over the British Islands at that season.

Equally interesting, and perhaps even more important than the Velocity of flight, is the Altitude at which it is performed. In my opinion, the vast importance of altitude in migration has never been recognized by naturalists. I will even go so far as

to say, that without a considerable altitude the migrations of many birds would be simply impossible; unless we were to attribute to these creatures mysterious and supernatural powers of perception, which would not only be most unscientific, but excessively absurd. That most birds fly unusually high during migration is, I think, an unquestionable fact. Witness the vast height to which Swallows and Swifts will soar just previous to departure, or the startling suddenness with which migrating birds will drop perpendicularly from the sky when their flight has been unexpectedly arrested by meteorological influences. Other proofs are to be found in the fact that migrants rarely strike against lighthouses except during spells of sudden darkness, due to fogs or clouds, which compel them to seek a lower altitude. Again, birds may be actually observed migrating at vast heights. Gätke records Rooks on passage flying so high that they looked like dust, and were only recognized by their cries. Of course, the size of large birds assists us to distinguish them at an altitude of many thousands of feet, especially those that habitually migrate by day; but small birds may wing their way entirely undetected at such enormous heights. Again, migration, as we have already stated, is mostly undertaken at night when birds cannot be seen at all, although their cries may be repeatedly heard obviously at a vast height as they wing their way across the starry skies. As another instance of vast altitude during migration, I may mention the fact

of Cranes being observed on passage at a great elevation crossing over the Pamir Plateau in Central Asia, a district which is upwards of 16,000 feet above the level of the sea. Much evidence might also be given of migration extending through lofty mountain passes, which it is only fair to presume are reached by horizontal flight, rather than by vertical flight from the plains below. Some of the most elevated land (not actually mountain summits) in the whole world is known to be the pathway of migratory birds.

By far the most important benefit derived from following an extreme lofty course is undoubtedly that of increased range of vision. The higher a bird flies the further it can see, the more extended becomes the visible segment of the earth's sphere below it. It is probably almost entirely due to its aerial existence that a bird's powers of perception and knowledge of locality are so acutely developed. There can be little doubt that the habit of constantly viewing the country at various heights, in all kinds of weather, and under ever-changing atmospheric influence, endows a bird with a knowledge of topography that seems to a terrestrial animal like man as little short of marvellous. The lay of the country can be seen at a glance from an aerial point of observation; and it is this well-known fact that leads a hunter lost in the forest to climb the nearest tree to ascertain his bearings. Each migratory bird must have a wonderful knowledge of the topography of its own particular routes, aided

by its marvellous power of memory and keenness of sight. I would suggest, however, that the migration flight reaches its highest altitude when passing over seas. These offer no landmarks, no bearings, nothing that may serve as a guide; consequently, the line of flight rises to a sufficient altitude to enable the bird to bridge the passage with its keen powers of vision. In confirmation of this, I may remark that in no part of the world do any regular migration routes cross seas too wide to be bridged by the eye of a bird flying at a sufficient altitude. The amount of the earth's surface within the compass of a bird's vision flying at any known altitude is easily calculated by spherical geometry; and, putting the average altitude at the very low estimate of from 1000 to 5000 feet, this will give a wide enough area for all practical purposes. That it is vastly exceeded, probably four- or five-fold, is unquestionable. From this lofty course the earth and sea for miles and miles will spread out below these migrating birds in one unbroken panorama; all the old familiar landmarks will be readily seen, each peculiarity of coast, already known so well by experience, descried. All the dangerous or unsuitable localities, all the favourite places of call, which years of former experience have taught them to avoid or visit, will be displayed below them in one broad and ever-changing expanse. This tendency to a lofty flight amounts almost to a passion as the time of migration approaches, and terrestrial birds that have kept close to the bushes or the

ground all the summer, suddenly become aerial, and mount upwards to pursue their way to distant lands. The majority of species appear to fly low as they near land; but others, as for instance the Woodcock, keep at a considerable altitude until the land is below them, when they drop suddenly down into the nearest cover.

There is another matter which bears very importantly on the altitude of Migration Flight, and that is the singular influence of bright lights on birds during passage. As every observer of migration knows, the various lighthouses and light-vessels that stud the seas and coasts across or along the routes of migration are frequently the centre of attraction of various pilgrim birds, most especially during a spell of fog or haze, or a few hours' prevalence of cloud. The question arises, Why do birds thus make for these fiery points of attraction, a proceeding which only too often ends with fatal results? It is out of no mere curiosity or desire to examine an unfamiliar object, for the visits are conditional and exceptional, whilst to many of these birds lights must have been common enough throughout the preceding summer. The most probable explanation is, that the sudden appearance of fog or the drifting of cloud-banks between them and the earth has caused them to lose their bearings, to flutter aimlessly down into a lower stratum of air, and then to make for the nearest object at all likely to guide them to a place of safety. The brilliant lamps of the lighthouse are too often the

only visible place for which to steer. An inherent knowledge teaches them that light leads to safety. Indeed, it is by no means improbable that reflected light acts as a great and important guide to migratory birds. Now, the most important routes of migration are near or over the great water-ways of the world —down river valleys and coast lines; or along the direction of mountain ranges, whose summits are usually more or less covered with snow in autumn and spring. Water and snow reflect light to a very great extent, and it is easy to conceive how a bird could gain some considerable knowledge of its general course by following the gleaming expanse below. The tide of migration flows high on moonlight nights; starlight is also favourable to its progress. Migration is discontinued during an overcast sky, when the moon and stars are shut out from the earth by a fog or cloud-veil, as is abundantly proved by the promptness of migrants to visit the lighthouses when the earth is for the time hidden in gloom, and the readiness with which the pilgrimage is resumed as soon as the heavens are clear again. If the fog, however, is of a local character only, migration is often continued above it, because the earth area which it conceals is not sufficiently large to cause birds to lose their bearings. Thus the seas, and lakes, and rivers, and snow-capped mountains, glistening in the cold white light of a brilliant moon, or gleaming gray yet full of reflected lustre from a star-lit sky, serve as so many flashing scintillating guides or steady glow-

ing beacons to the birds flying on, and on, and on above them!

We may allude to several other possible advantages that may be gained by a lofty flight. The mere mechanical labour of flight is rendered much easier of performance in the more rarefied atmosphere of these lofty regions of space. This is a matter of great importance to species whose fly-lines are very extensive, for they are thus able to fly *longer* with less fatigue, and *quicker* than in the lower and denser atmosphere—two things very essential to the successful performance of their journey. The currents of air at a great altitude may also be more uniform and favourable, whilst lower down, the air stream may be blowing in a direction quite unsuited to Flight. Another advantage of a lofty course is the greater immunity from enemies, a very important item in migration, as we have yet to learn. Far up in the sky, especially when shrouded in gloom, the way is free from danger; and small birds, even in daylight, are not readily discerned at any great height above the earth. One other advantage to diurnal migrants especially is the lengthened period of daylight. The valleys are hidden in gloom long after the mountain tops continue to reflect the light of the setting sun; and these lofty summits catch the dawn long before it reaches the lower country. I have already alluded to the possible use of the balloon in studying Migration (see *Idle Hours with Nature*, p. 217), and here I would seek to emphasize my

previous suggestion. That a captive balloon floated above some spot where migration is notoriously prevalent, as for instance at Spurn Point on the Yorkshire coast, in the Wash, on the Sussex Downs, or better still, over Heligoland, would result in priceless information concerning the annual movements of birds, is absolutely certain. The more I study Migration, the more I feel convinced that it is a nocturnal drama of the air, and that only a faint conception of its wonders can be formed from terrestrial scrutiny. I shall be happy to assist in any such investigation. Will the British Association for the Advancement of Science, which has already done so much for the elucidation of the Pilgrimage of the Birds, still further lend its all-powerful assistance towards establishing such aerial posts of observation?

The various notes uttered by birds on migration must not be forgotten. Some species are much more noisy on passage than others, and many birds keep up quite a chorus of cries as they wing their way along. That these notes serve the important purpose of keeping migrating flocks together seems unquestionable. The cries of birds may be heard repeatedly at night during the two seasons of passage, as flock after flock of migrants crosses over the darkened sky. These notes may also serve as guides to the young and inexperienced, keeping them to the true course; whilst the birds that fly in silence may be kept in touch of the route by hearing the cries of more noisy species.

Geese, for instance, are noisy during Flight; so too are Waders. Crows, however, especially when migrating by day, are silent birds; but Larks, whether on passage by day or by night, are incessantly calling to each other, and very frequently burst out into song the moment they reach land during daylight. Many a time the only sign on earth that a great migration of birds is in progress, is by hearing the varied and oft-repeated notes, sounding faintly from on high as the armies of birds pass on in the darkness overhead.

A few words on Wind and Temperature will bring these meagre remarks on the philosophy of a great subject to a close. There can be no doubt that wind has a great influence on the migratory movements of birds. It is not every wind that is favourable to Flight; tempests arrest migration almost entirely; adverse winds retard it; but a gale, if from a suitable quarter, often seems more to assist it than otherwise. Strong head winds are always avoided if possible, for the obvious reason that a long-continued flight would be made with a maximum of labour and a minimum of progress. A wind blowing directly behind is also unfavourable to Migration Flight, for the cold current blows up through the plumage and chills the body of the flying bird. The favourite wind is a shoulder wind, what in nautical parlance is known as a "beam wind," or a wind blowing more or less obliquely across the line of flight. The direction of flight is usually within three or four points of the wind.

A southern migration is therefore best performed, not as some readers might imagine with a north wind blowing directly behind the travellers, but with a south-easterly or north-westerly wind blowing obliquely across their path. A northern migration is best advanced by north-easterly winds. Very light head winds are often favourable to migration; and in rarer instances migrants pass to windward with a gentle and warm breeze. Birds are very careful in their choice of wind, and nothing retards migration so much as contrary currents, the little travellers often waiting for days until a favourable breeze springs up, and they can renew their flight. Sudden gales from adverse quarters will frequently blow migrants hundreds of miles out of their proper course with fatal results, and occasionally bring them to countries which they would never normally have visited.

The influence of Temperature on migrating birds has not yet been studied sufficiently well to furnish much reliable data on which any very important generalizations or conclusions may be based. That it has important effects on Migration Flight can scarcely be doubted, and it is sincerely to be hoped that observers when recording migratory movements will pay due care to this portion of the subject. Rises and falls of temperature are evidently very important impelling causes of migration, especially of nomadic migration. It is even possible, if we allow ourselves to roam for a moment into the speculative realms of theory, that the

gradual rise of temperature experienced as the several zones of the earth are crossed from north to south, may serve as some guiding influence, attraction, or gentle impetus to birds in search of warmer lands in autumn; just as the fall in temperature experienced in a passage from the Tropics to the Temperate or Arctic zones might act inversely in spring. Birds migrate in spring to regions where the temperature is suitable to the vital function of Reproduction—and it is an axiom in ornithology that birds in the warmest areas of their distribution or habitat select the coolest areas of temperature in which to breed. In autumn, birds are in quest of higher temperature, or rather retreating from regions where the temperature is rapidly falling. That birds, like many other animals, may be able to foretell the near approach of barometrical disturbance, that this finely-adjusted faculty is of vital importance to such mighty travellers, seems so palpable that we can scarcely question its truth, although in the present state of our knowledge we fail to see how or why. Mr. J. A. Allen has remarked that in America the migrations of various birds precede storms or sudden falls of temperature often only by a few hours, thus avoiding these disturbances by keeping ahead of them. Great migratory movements have repeatedly been observed coincidently with favourable barometric conditions, and to cease with the reverse. We shall have occasion to allude to the influences of Temperature on Migration Flight again.

CHAPTER IV.

ROUTES OF MIGRATION.

Intricate Nature of Fly-lines—Sea Routes of Migration—Migration over the Azores—Migration at the Bermudas—Its Abnormal Character—Migration over Seas by means of Islands—Migration over the Mediterranean—The North Sea Routes—Rarity of Migration to New Zealand—Migration Routes Continuous—Antarctic Migration—Geological Changes in Antarctic Regions—Coast Routes of Migration—Their Continuity—How followed by Migrants—Ancient Routes of Migration—Instances of Species still following them—Submerged Land Areas—Coast Migrants—Valley Routes of Migration—Cross Valley Routes—Valley Routes to India—Abnormal Migrants to that Country—American River Routes—River Valleys exceptionally favourable to Migrants—Mountain Routes of Migration—Mountain Migrants—Migration through Mountain Passes—Varied Character of Migration Routes—Routes of Migration indicating Emigration.

The next portion of our subject with which it becomes necessary to deal, embraces the various Routes that are followed by migratory birds. These highways of migration are both numerous and well recognized; many of them are extremely complicated. Probably the fly-line of no two species is exactly the same; and the variety of route seems almost as excessive among individuals as among species. Each appears to follow a route which

past experience has taught it to be the best for its own requirements, or the countless contingencies and necessities of migration have compelled it to learn. Consequently, we come across many apparent anomalies in studying the fly-lines of birds; we shall find them intricately interlaced and even crossing each other at right angles; running parallel but reversed by certain species according to season; turning without any apparent cause. If it were only possible to focus the Palæarctic or Nearctic region into a bird's-eye view during the months that migration is in progress in spring and autumn, and to be able to see the various species *en route*, each following its chosen course, the whole movement would appear to be in the wildest confusion. Birds would be seen flying this way and that, crossing each other's path, or following it for a certain distance, then quitting it again, passing each other in opposite streams, or gathering in certain localities to separate again as soon as they were crossed, flying from many points of the compass, intricately mixed, yet all orderly following the chosen path which leads to the desired destination!

As we have already seen, Migration is not a capricious habit; we shall soon learn that the Routes which are followed are almost as ancient as that habit, and are adhered to in a very persistent way. Broadly speaking, the majority of migratory birds visit northern regions in spring and southern regions in autumn (so far as the Northern Hemisphere species are concerned); there is a vast double

exodus from north to south, and from south to north, every year. Any person ignorant of the subject might infer, and reasonably so, that this vast army of pilgrim birds passed to and fro without any regard for order or route; that each strove as best it could to reach the summer home or the winter quarters. But the very reverse is the case. For birds follow certain routes, and in some cases even modify their habits considerably to do so; some inland species becoming for the time being littoral; others, marine species, quitting their coastal habitat to follow a certain fly-line. This persistent attachment to old routes of migration is exemplified in a very remarkable manner by the present geographical distribution of certain species, as I hope presently to show.

The great routes of migration whether over land or sea are closely connected with the configurations of the earth's surface. We may for the sake of convenience divide them into four very marked classes, viz.: Sea Routes, Coast Routes, Mountain Routes, and River or Valley Routes. The first of these highways is the one followed more especially by aquatic birds; land birds are not known in any part of the world habitually to cross seas for much more than 400 miles, unless there are intermediate stages in the form of islands on which they may rest, if necessary. The two longest routes of migration over the sea which land birds are known to follow, are first in the Atlantic Ocean between the Azores and Portugal, a distance of 900 miles;

and Madeira, a distance of some 550 miles. There is, however, no evidence to show that the migration of land birds over these islands is of any importance, whilst the few that do occur normally are principally Waders, birds well adapted, as we have seen, for extended flights. The land birds of this group are resident, or only classed as accidental stragglers, and only three species are non-European. That these resident individuals remain unmodified, is however a somewhat convincing proof that many individuals from Europe drift to the islands from time to time and interbreed with them. It is also worthy of remark that with only one exception (the Red-legged Partridge *Caccabis rufa*, which was probably introduced), the fifteen resident European land birds are all species of known migratory habits, a fact which suggests the colonization of these islands by birds that had wandered or been driven out of their usual course during passage. Our second instance is the ocean passage between the continent of North America and the Bermudas. The nearest land is North Carolina, a distance of 700 miles, which, as it is in nearly the same latitude, does not fairly represent the sea passage of possible migrants. North of these islands the nearest land is Cape Sable, about 750 miles distant. This is by far the longest ocean passage habitually taken by any migratory land bird on record; and it is difficult to believe that the flight is ever made from choice, or is customary with some individuals of certain species. The great bulk of the birds that

visit these islands on passage are Ducks and other aquatic species; and it seems more than probable that all the land birds which do so are individuals blown out of their normal course along the eastern coasts of North America by violent storms. The passage south (the period when the occurrences are most numerous) is made at a season when storms are remarkably prevalent. Violent gales are almost of weekly occurrence in this region, and seldom fail to bring numbers of migratory birds to the islands. It is suggested that many of these wind-driven migrants may have been carried up by local whirlwinds, and borne out to sea by westerly or north-westerly gales prevailing in the upper atmosphere. The greater number of these birds most probably perish, but a few manage to reach these islands more or less regularly every year, the regular arrivals (such as *Ceryle alcyon*, *Sciurus novæ boracensis*, and *Dolichonyx oryzivora*) being those whose migrations, either from their altitude or date of progress, are probably most exposed to sudden atmospheric disturbance. Migration, as we have seen, does not generally go on during gales, so that the visits of these birds to the Bermudas seem compulsory rather than voluntary, abnormal rather than regular, and we are perfectly justified in concluding that these islands as well as the Azores are far removed from all ordinary Routes of Migration.

Wherever islands dot the narrow seas between, or fringe the coast-line of continents, migration

over them is both extensive and regular; and it is also by the aid of islands that such vast areas of sea are crossed as extend, for instance, between Japan, the Malay Archipelago, and Australia. In the same way deserts are crossed by stages from oasis to oasis. It is also owing to this fact that oceanic migration is practically unknown among land birds, and that sea migration is so extensive. For instance, the Wheatear (*Saxicola œnanthe*) can and does travel from North Greenland or Spitzbergen to the Equator without having to cross the sea for more than 300 miles at any point of its route. From Greenland its fly-line crosses Iceland, the Faroes, the Shetlands, the mainland of the British Islands, France, the Spanish Peninsula, the Straits of Gibraltar, and ends in Africa. The fly-line of birds travelling from Spitzbergen crosses the Arctic Ocean over several small islands to Scandinavia, thence either across by way of Fair Isle and the Orkneys to the British Islands, or down the continental coast-line to Heligoland, and onwards to France and the South. There is probably more migration across the Mediterranean than any other sea in the world. It is the great divide between the summer and winter quarters of nearly half the birds of the Palæarctic region; and yet the passage over it is by no means a promiscuous one, but it is made with due regard to what are evidently very ancient routes. All or nearly all the migrants from the extreme west of Europe, including the British Islands, enter Africa by way

of the Straits of Gibraltar, the Balearic Isles, Sardinia, and Sicily; those from Eastern Europe by way of the Greek Archipelago and Candia, the Black Sea and Cyprus. There is also a very considerable amount of migration across the North Sea, which is the route chosen by many birds on their way from Scandinavia to the British Islands, crossing from the Dovrefjeld in Norway to the Shetlands, where the water passage is not more than a couple of hundred miles. Birds either come by this route to our islands, either to winter or to pass still further south; or follow the continental land and cross by way of Heligoland and the Straits of Dover. A very important stream of migration also crosses this sea nearly due east and west, but there is little or no evidence to show that the passage is made across the widest part. It is very significant how few Palæarctic birds extend their migrations to New Zealand, compared with the number that regularly visit Australia, South Africa, or South America. New Zealand is so remarkably isolated that an ocean flight of upwards of 700 miles without a break of any kind is necessary to reach it. Of the great number of migratory birds that leave the east Palæarctic region and China in autumn to winter in the Malay Archipelago, New Guinea, and Australia (across seas thickly studded with islands), scarcely any extend their migration to New Zealand, either wisely declining the long continuous ocean passage, or totally ignorant of that country's existence.

All these facts tend to show that Migration Routes, broadly speaking, are *continuous*, and that it is only under such a condition that Migration ever became a possibility, or even had an existence. Widely disconnected sea routes of migration are as rare as discontinuous areas of distribution, and in many cases not only terminate in emigration, but ultimately in segregation and the establishment of new races. Had there been no means of slowly acquiring the habit in past ages by easy sea passages, or by a continuous land area from north to south or from east to west, had broad expanses of ocean barred the way of retreating birds during periods of climatal change, all the ancestors of our northern avifauna would either have perished or reached southern lands never to return; or if some did succeed in returning they would have come as emigrants, and migration would have been unknown! Tested by such facts as are here adduced, it would seem that the migration from the Antarctic regions, which in a previous chapter I have suggested took place on a very important scale in past ages, must be an erroneous conclusion. But the difficulty is more imaginary than real. Even at the present day most of the vast ocean space between the now glaciated Antarctic continent and the two great land masses of America and Asia may be so bridged by islands that the continuous water passage does not exceed 500 miles, except to the south of New Zealand (700 miles), and to the south of Africa (1500 miles). From this we may naturally infer

that probably the great highways of Antarctic migration were Pacific rather than Atlantic, by way of Australia and South America. The evidence of a migration route across the sea south of Africa is not so abundant or so conclusive, but certainly exists in the very obvious dispersal of the Swallows (HIRUNDINIDÆ) from the Antarctic regions, and by the presence of a few isolated species of CHARADRIIDÆ in that region. These latter are few, however, and unsatisfactory in comparison with the numerous species (some of them obviously ancestral) left behind in the Australian and Neotropical regions. We must also remember that vast and important geological change has taken place in these Antarctic latitudes during Secondary and early Tertiary time. We have direct evidence of land connection between Australia and New Zealand during the former epoch, and probably much land has been submerged (possibly owing to excessive glaciation) between New Zealand and the Antarctic continent, and even between South Africa and that region. The Ethiopian Swallows are direct evidence of an ancient Antarctic migration, which, judged by its present philosophy, must have received land assistance in its passage south of Africa, although those ancient stages have long passed away. At no time, however, judged by the much more exacting botanical evidence, has the Antarctic region been so closely bridged with Africa as it has undoubtedly been with Australia and South America; and this fact is further emphasized by the notoriously great

powers of wing possessed by Swallows and the great altitude at which they fly, indicating the longest possible inter-ocean migratory flights.

From the above facts we may infer that sea routes of migration are either short routes, or if prolonged over waters of moderate extent, that islands invariably assist the passage when taken under normal circumstances. I also think, as previously stated, that the altitude of migration flight is much greater over a sea route than a land route, for the obvious reason that landmarks are less numerous and further apart.

The second of these great Migration Highways is that which follows the Coast-lines of the world. The contour of the great continents is singularly favourable to Migration Flight, not only in general direction, but in its continuity. Coast-lines divide themselves very naturally into six great groups. Firstly, we have the East Atlantic coast-line, stretching in almost unbroken continuity from the North Cape in Scandinavia to the Cape of Good Hope in South Africa, a distance which may be roughly estimated at some 10,000 miles. Secondly, we have the West Atlantic coast-line extending from Grinnell Land and Greenland in one majestic and unbroken course down to Cape Horn in Patagonia, and covering, we will say, 14,000 miles. Thirdly, we have the East Pacific coast-line reaching from Point Barrow in Alaska continuously to Cape Horn, and which may be roughly estimated at 12,000 miles. Fourthly, we have the West Pacific

coast-line, by far the most broken and interrupted of all, reaching from Cape Serdze in north-east Siberia to Tasmania, which may be roughly estimated at some 10,000 miles. Fifthly, we have the West Indian Ocean coast-line, extending from Suez to the Cape of Good Hope, a distance of some 6000 miles; and sixthly, the East Indian Ocean coast-line, reaching from the head of the Persian Gulf to Tasmania, a distance of, say 10,000 miles.

From these facts it may readily be seen that birds which follow coast-lines have practically a continuous road, easy to follow, stretching from one hemisphere to the other, and long enough to include the limits of all but the few very widest migratory flights. Birds do not, however, strictly confine their flight to all the indentations of a coast-line. Were they to do so, the length of their journey would be enormously increased. It may be laid down as a pretty general rule that during actual migration flight along a coast, all the bays are avoided in which the boundary headlands are visible by the species of most powerful wing; that only the narrow inlets are crossed by the less powerful winged; and only the weakest fliers of all follow the winding course of the land. Promontories are also crossed to a very great extent. That this is a fact is easily proved by the vast number of birds that cross a headland, compared with the small number that may be observed in deep indentations of the coast; always excepting, of course, the normal migration into any area, which often

enters by such channels. Bad weather occasionally keeps all birds close to the coast-line, and thus modifies their direct line of flight. The coast migration of Eastern America, from what evidence I can glean on the subject, appears to cross from Florida to the West Indies, rather than follow the continental coast of the Gulf of Mexico to South America. I might give many instances of birds on their way south from the Eastern States to South America that cross the West Indies and Trinidad. Another very interesting fact connected with coast migration, is the remarkable way in which certain birds suddenly alter their course by leaving a coast and starting directly across the sea. These birds are supposed to be following old migration routes—ancient coast-lines now submerged beneath the waves. The known great attachment of birds to their fly-lines makes this explanation feasible, and it is still further confirmed by direct geological evidence. There is some evidence, for instance, that birds follow an ancient coast-line once reaching from Spurn Point in Yorkshire to Denmark or Holland, in the fact that several species are known to migrate along the East coast of England up to this point, and then to strike across the sea, seldom or never being observed further north: the Knot (*Tringa canutus*), the Bar-tailed Godwit (*Limosa rufa*), and the Gray Plover (*Charadrius helveticus*), may be mentioned as examples. Another ancient coast-line followed by the Knot, the Asiatic Golden Plover (*Charadrius fulvus*), and the eastern form of

the Bar-tailed Godwit (*Limosa rufa uropygialis*), appears to lie between New Caledonia and New Zealand, part of which, in the form of Norfolk Island, still remains above the surface of the ocean. The fly-lines of *Totanus incanus* also appear to suggest a submerged route across the Pacific from Alaska to Polynesia. One more instance, and that perhaps the most interesting, must be given. The geographical distribution of the eastern form of the Orange-legged Hobby (*Falco amurensis*) has long been a puzzle to naturalists. This bird breeds in Eastern Siberia, Mongolia, and North China, and winters in India and South-east Africa; although how it reaches the latter country, and for what reason, has never been satisfactorily determined. The only possible explanation is, that this bird follows an ancient route across the Indian Ocean, much of which has become submerged, although sufficient is left not only to guide the bird on its ocean pilgrimage, but to indicate the position of the sunken land, in the form of the *Maldive Islands*, the *Chagos Archipelago*, the Seychelles, Amurante Island, and the *Saya de Malha Banks* (the names in italics probably show the route followed). The individuals of the Common Hoopoe (*Upupa epops*), that winter in Madagascar, also most probably follow this ancient fly-line, as that bird is otherwise unknown in Africa south of the Equator. That at no very remote age there were considerable land masses along this route (Lemuria), is not only proved by the present conditions of the ocean-bed,

but by the presence of many Indian avian types in Madagascar, not only of genera but of species, some of the latter being hardly distinguishable. That it was also at no very remote period a regular route for migrants by way of the Indian Peninsula, is equally certain, as the present migrations of this Falcon undoubtedly demonstrate. The occurrence of the east Palæarctic Cuckoo (*Cuculus himalayanus*) in Madagascar also suggests a passage across this ocean; and the presence of *Cuculus gularis* and *Cuculus capensis* in South-east Africa appears to me to indicate an Emigration by the same route. Future research may yet show that *Cuculus himalayanus* is as regular in its visits to Madagascar as *Falco amurensis*. This route is also, I believe, one of the fly-lines of the Curlew Sandpiper (*Tringa subarquata*) to South Africa, a fact confirmed by that bird only occurring on passage in Madagascar (*fide* M. Pollen). This route of Emigration may also possibly explain, among various other instances, the presence of *Rhynchæa capensis* in Madagascar and continental Africa; and of *Glareola ocularis* in Madagascar, whose nearest ally is the Oriental *Glareola orientalis;* more especially so as it appears even now occasionally to visit the outlying islands (Mauritius, *fide* Grandidier). This route may yet be shown to be a regular fly-line of other east Palæarctic birds, especially of such that are gifted with great powers of flight; for it must be remembered that the widest water-stages are quite 600 miles across. It is probably owing to that

fact that most of the migration by this route has ceased.

We have only instanced the most important coast routes of migration, but there are innumerable others in all parts of the world, both of seas and large lakes, which are followed by various species during passage. Witness the vast number of migrants that pass the coast-lines of the British Islands, or follow the shores of the Bothnian Gulf, the Baltic, the White, Mediterranean, Black, and Caspian Seas in the western Palæarctic region; the shores of Lake Baikal, and the Great Lakes of North America. It would require a chapter to particularize them all. The coast routes are more especially the migration highways of great numbers of Waders (CHARADRIIDÆ) and Ducks (ANATIDÆ); the abundance of food is probably the chief reason for this choice. As soon as the breeding season is over these birds begin to congregate on or off the nearest coasts, and gradually move south along them, many species remaining on them all the winter in the far south, and passing north again by exactly the same route. That a vast number of land birds, especially Passeres, follow coast-lines, is also equally certain; but these must take such routes primarily for the sake of an unfailing guide which trends in the precise direction they wish to go, rather than from any partiality for littoral haunts. Coast routes, then, are the recognized Highways of Migration, followed by hosts of birds throughout the world. Great numbers of these

birds come from considerable distances inland, following local routes or bye-ways to join the great trunk road which all then follow in common according to their specific time.

On the other hand, however, equally large numbers of species, and even of individuals, whose habitat is in the interior of mighty continents, are too far removed from such coastal highways, either to be aware of their very existence, or to render a cross flight impracticable, and these birds have naturally chosen other configurations of the earth's surface to serve as great trunk roads for their annual migrations. Unquestionably the most important of these are the great river valleys which sere the earth's surface from north to south in so many countries visited by migratory birds. To a very great extent all the small tributaries which drain the haunts of these migrants are followed until the main valley is reached and the trunk fly-line joined. On all the great continents there are river valleys known to be crowded with migrants passing along them in spring and autumn. In Europe the most important River Routes are as follows. Firstly, the valleys of the Petchora, north and south Dvina, and Onega, which lead to the various upper waters of the Volga, the Don, and the Dnieper, along which all the migratory land birds of Russia journey south to the Black and Caspian Basins, and thence (by the coast routes of those great inland seas) to East Persia, Asia Minor, and Egypt. Secondly, the Vistula, the

Oder, the Elbe, and the Rhine, which connect with the Danube system, which leads on to Turkey, Greece, and the East Mediterranean sea routes, and along which many of the migrants from the East to the British Islands and from Scandinavia journey to and fro. In Africa, which is practically a continuation of the direct routes from Europe, the most important river highway is the Nile Valley, which receives an incredible number of migrants from Russia, Asia Minor, and Syria—most of them species that winter far to the south in that continent. The Niger Valleys, but on a much less important scale, drain some of the migration which spreads across North-west Africa; but in the west of the continent coast routes predominate. In Asia the great river valleys are singularly well situated for migration, and the number of birds that pass along them on flight is past all belief. The migrations of almost every species of migratory east Palæarctic birds may be traced along them. The three great northern river-systems are those of the Obb, the Yenesay, and the Lena. Not only do the main valleys of these vast waterways favour a direct flight towards the winter quarters of birds due south of them, but their endless south-westerly trending feeder valleys favour the migration of those birds breeding in the east Palæarctic region, and wintering in the Ethiopian region. By these cross valley routes many species whose eastern range in summer extends as far as the Yenesay (which is on the

meridian of Calcutta), journey to winter quarters in Africa. Some of these cross valley fly-lines are little short of marvellous. The Great Snipe (*Scolopax major*) manages partly by their aid to reach Central Siberia from South Africa, its only known winter quarters. The Little Gull (*Larus minutus*) crosses Siberia from end to end by means of these water-ways, breeding on the shores of the Sea of Ochotsk, and wintering in the Caspian Basin! That the latter bird must keep to the water *en route* is imperative owing to its aquatic habits. Other great river routes of migration are the valley of the Amoor, which is principally used by birds travelling between East Siberia and China, Mongolia and India; the Hoangho and the Yangtse, which drain Mantchooria and North China, and feed Burma and India, *viâ* the Brahmapootra and Ganges. Mr. F. W. Styan (*Ibis*, 1890, p. 317) records no less than ninety-seven species of birds which regularly pass along the Yangtse on passage, many on their way to the far north, from the Siamese Peninsula and Burma, many to cross the Yellow Sea and breed in Japan. There appears to be a very considerable stream of migration enter North-east India down the valley of the Brahmapootra. One very direct instance is furnished by the Pintail Snipe (*Scolopax stenura*). This bird breeds in East Siberia, and winters in India, Burma, the Siamese Peninsula, and the Malay Archipelago. Its only fly-line into India is apparently down the Brahmapootra Valley, since the bird is quite

unknown in the north-west of that country. It swarms in the adjoining valley of the Yangtse, which is a continuation of its fly-line to the northern summer haunts. Again, it is apparently by this route that many rare Eastern stragglers to India enter that empire and follow the Ganges. The Crested Teal (*Anas falcata*) and the Baikal Teal (*Anas formosa*) may be mentioned as instances, both of which species are common winter visitors to the Yangtse. Other important Asiatic river routes are along the Ganges, the Indus, and the Oxus, forming the great valley passages into India from the north-west; and the Tigris and Euphrates, which assist the passage of birds breeding in Europe and wintering in Asia. Instances of the latter, however, are rare. The two most interesting are perhaps the Rose-coloured Pastor (*Pastor roseus*) and the Black-headed Bunting (*Emberiza melanocephala*), which visit South Europe as far west as Italy in summer, and are only known to winter in India. The great water-ways of North America, stretching as they do directly and almost continuously from Alaska to Mexico, are also routes of migration of the highest importance, seeing that coast routes can only be followed by a very small percentage of the birds visiting an area in which the two coasts are nearly 3000 miles apart. To a very great extent migration from the North-west follows the Mackenzie River, and the various water-ways that lead to the largest lake system on the earth's surface; and doubtless a good deal of coast

migration passes along the shores of these vast inland sheets of water. There is much evidence to show that the noble St. Lawrence is a fly-line of many northern Nearctic species; whilst further south the stream of migration is carried along the various valleys of the Mississippi, Missouri, and Ohio. These latter to a great extent carry off the migrants of the United States between the Rockies and the Alleghany Mountains. The migrants from the east of these latter mountains appear to follow the numerous streams that lead to the Atlantic coast-line; whilst those from the west of the Rockies follow similar streams to the Pacific coast.

Our knowledge of the ornithology of South America is so meagre in its details that we have next to no data on which to form an opinion as to the value of river valleys as highways of migration. There cannot, however, be much doubt that such favourably-placed valleys as those of the Parana, the Paraguay, and the Uruguay, trending nearly due north and south for 1500 miles, have a very important influence on migration in the wide districts which they affect.

That migration follows these great inland valley routes is abundantly proved by what has actually been observed in them. Wherever competent observers have noted the seasonal movements of birds along them, the facts are essentially the same. Down all these great valleys Migration ebbs and flows in no uncertain trickling stream, but in

mighty torrents which testify each recurring season to their vital importance as Highways of pilgrim birds. The river fly-lines equal in length those of the longest coast routes; and although in our present state of knowledge we cannot trace the absolute route taken by more than a few individual species, we are enabled from our general information respecting their geographical distribution broadly to determine the general course of a very great number of others. River valleys are exceptionally favourable migration routes. The great variety of species following them can obtain abundance of food either on their waters, on their banks, or amidst the rich vegetation which clothes the slopes above the stream. Thus, we find that birds of all kinds follow the course of rivers; land birds and water birds, the insect- or seed-eating Passeres, the swamp-loving Waders, the aquatic Ducks, even the oceanic Gull or Tern—all are equally favoured. They also enable birds to reach their breeding-grounds in the Arctic regions at the earliest possible moment, which is of the greatest importance in a land where summer, if hot and brilliant, is remarkably short.

It remains for us now to notice Mountain Routes. Although these are perhaps followed least frequently of all, we have a considerable amount of evidence to prove that they are not only widely used, but of very great importance. As we have already seen, mountain chains in many cases act as landmarks and guides to the migrating birds that

follow them, just as coast-lines and valleys do. They also enable birds to make certain well-recognized and easily-remembered entrances to countries they pass on passage, or visit during summer or winter. We have direct evidence that the lower slopes of mountains are direct highways of migration. Even in England the Downs are a noted path for migrants; and a great many species may be traced along the mountain chains of our islands during the season of their passage. Birds that belong to a mountain or upland habitat are the most addicted to these routes. The Ring Ouzel (*Merula torquata*), various species of Chat (*Saxicola* and *Pratincola*), the Dotterel (*Eudromias morinellus*), and a few Waders, are all decided mountain followers. We have also the direct testimony of the most accurate field ornithologists to prove that flocks of birds on passage may frequently be seen above mountain ranges, following the chain. Some of the most interesting instances of migration may be witnessed at the great mountain passes, birds journeying through lofty defiles with as much appreciation of their usefulness as human travellers. Great numbers of birds pass the Pyrenees, the Caucasus, and the Alps on migration. One of the most famous passes for migrants in the Pyrenees is the "Jaisquivel," another the "Palomeras de Eshalar"; whilst the "Albula" and "Bermina" passes into the Adda Valley and Lake Como, in the Alps, are others. The Himalayan passes are also great routes of migrants. Dr. Scully, an

ornithologist of wide Indian experience, and for some time stationed at Gilgit in the North-west Himalayas, informs me of the wonderful amount of migration in and out of India of Palæarctic birds through the passes of this wild upland region —a stream of migration which is continued along the valley of the Indus, as previously noted. The Pamir Plateaux, otherwise known as "the roof of the world," in Central Asia, is another important route of migration, as the late Dr. Severtzow's observations abundantly prove. In North Africa, the Atlas mountains are followed by many migrants on their way from Morocco and Algeria to Europe, *viâ* Sardinia, Corsica, and Sicily. Our information respecting mountain routes in the New World is not very great; but there can be little doubt that they are important, more especially as the ranges there are almost parallel to the coast-lines. As guides they must prove of inestimable service.

From the above remarks it will readily be seen that the several great Routes of Migration are of a very varied character; and when in addition to them we take into account the numberless local routes, of which it would not be possible to name more than a tithe, we can form some idea, if only of the slightest kind, of the complicated nature of these avian fly-lines. It must also be remembered that probably very few birds keep exclusively to one or other of these routes, but make use of all, or at least several of them, during their seasonal flights. A bird in its journey from South Africa

to the tundras of Northern Europe or Asia probably follows all in turn. It has an experience of Valley Routes in the Nile, the Don, the Volga, and the Petchora; of Sea Routes across the Mediterranean by way of Cyprus or Candia, and the Greek Archipelago; of Coast Routes along the shores of the Black Sea; and probably of Mountain Routes in the Caucasus—each and all of which long ages of accumulated experience have taught that species to make the fullest use. Some of these routes are much more direct than others; many are excessively circuitous, and vividly illustrate the gradual way in which a species has spread from a centre of dispersal, turned this way and that by endless conflicting influences in the unceasing struggle for place and for life. Here a desert stopped the way, and a fly-line to avoid it had slowly to be learnt; there some other dominant and vigorous species already held the ground, causing a *détour* or even a retreat; here a mountain pass led to new areas of dispersal, and fields for Emigration; there conditions of life peremptorily forbade settlement or increase—all this and more is indelibly stamped upon the present fly-lines of every species, had we only perceptive power enough to decipher it. For, depend upon it, these tortuous Routes of Migration are the hieroglyphics which record the Line of Emigration followed by species in past ages, and unquestionably demonstrate the only feasible way in which the road has been learnt!

CHAPTER V.

EMIGRATION AND EVOLUTION.

Confusion between Emigration and Migration—Definition of Terms—Theories of Avian Distribution—Primary Causes of Emigration—Local Causes of Emigration—Irruptic Emigration—Irruptions of Sand Grouse—Irruptions of Pastors, Jays, and Goldcrests—Chronic Emigration—Birds extending their Range—Present Lines of Migration an Indication of Past Routes of Emigration—Ancient Routes of Emigration—Emigration of Ouzels and Snipes—Recent Avian Emigration in the British Islands—Emigrations of House Sparrow—Emigration resulting in Migration—Emigration and Evolution—North Polar Emigration caused by Glacial Epoch—Island Species of Birds—Islands and Routes of Migration—Influence on Insular Avifaunas—Avifauna of the Galapagos Islands—Avifauna of the Bermudas—Avifauna of British Islands—British Local Races—Evidence of Emigration in British Islands—Importance of Emigration.

The subjects of the present chapter are so closely, I may say inseparably, connected with Migration that it becomes absolutely necessary to include them if we desire to make the history and philosophy of our subject even reasonably complete. We have had, and shall continue to have, occasion to allude casually to the Emigration of Birds; we will therefore devote the present chapter to its discussion in greater detail. There is not a little popular

confusion between the two words Emigration and Migration; by many persons they are regarded as synonymous expressions, and applied indiscriminately to these very distinct avian movements. When the term Emigration is applied to birds, it is intended to express a colonizing movement, a journey with no return, or a spasmodic or gradual extension of geographical area. By the term Migration, a regular passage between two districts or regions is implied. Emigration is either fitful and irregular, or very gradual if constant; Migration is both regular, constant, and seasonal.

The present universal distribution of Birds over the earth's surface can only be accounted for in one of two ways. Either we must admit that every bird was created in the area which it now occupies, or that birds have emigrated in endless directions from centres of dispersal. The former explanation demands the acceptance of the theory of Special Creation, a theory that all the teachings of modern science have utterly exploded, and proved to be as illogical as it is false. The latter explanation, the theory of Evolution, of Descent with Modification, which implies that birds have sprung from common ancestors, is completely in harmony with the facts that are presented to us, not only in the present distribution of animal life, but with the vast changes that our globe has suffered in past ages.

The most important causes of emigration, and those which have probably had the most influence on this means of dispersal, are the great climatal

changes that we have already dwelt upon at some length in an earlier chapter. The two last Glacial Epochs (at the South and North Pole respectively) were vast incentives to emigration, causing it to be undertaken on a scale, so far as the class Aves is concerned, never equalled before or since those periods. And not only were the emigrants dispersed from these desolated Polar centres, but their influx in lower latitudes must have had such a disturbing influence on avian life in those latitudes, as to lead, through more severe conditions of life (owing to competition with invading species), to much emigration amongst southern forms as well. The next great cause of emigration is the vast and almost universal amount of glaciation which has taken place on every continent during periods of high orbital eccentricity. "In the Alps," says Wallace, "the Pyrenees, in the British Isles and Scandinavia, in Spain and the Atlas, in the Caucasus and the Himalayas, in Eastern North America and West of the Rocky Mountains, in the Andes, in the mountains of Brazil, in South Africa, and in New Zealand, huge moraines, and other unmistakable ice-marks, attest the universal descent of the snow-line for several thousand feet below its present level." That such ice action produced much climatal change and direct banishment of organic life is indisputable; and that the influx of birds from hill districts to plains and valleys necessitated emigration on a wide scale among upland and lowland species alike, can scarcely be doubted.

More local, but none the less certain, causes of emigration may be found in the great numerical increase of species, rendering the dispersal of the surplus population into new regions indispensable and imperative. This may happen in two ways. Either a vast wave of surplus population may suddenly spread out from the congested districts—an irruption, or even series of irruptions, within a comparatively short period of time, flowing across wide areas until gradually spent; or, under favourable conditions, a species may slowly extend its range from a comparatively small centre until it ultimately covers an enormous area. As an example of Irruptic Emigration we have the intensely interesting emigrations of Pallas's Sand Grouse (*Syrrhaptes paradoxus*) from Central Asia, which have from time to time occurred with startling suddenness. This species for the past fifty years or so has evidently been in a very restless and disturbed state, and from time to time great waves of emigrants have been thrown out apparently to relieve a congested area of distribution. Pallas's Sand Grouse normally is an inhabitant of the vast plains or steppes that stretch continuously from north-east Turkestan and South Siberia to Mongolia. In the north it is a migratory bird, and the winter range extends into North China in the east and the Kirghiz Steppes north of the Aral Sea in the west. Until 1859 this species was practically unknown to western ornithologists, although Russian naturalists had met with it from time to time in its far eastern

habitat. In that year, however, the first signs of the coming irruptions broke into Europe, and examples of this Sand Grouse were obtained in Poland, Jutland, Holland, and the British Islands. It is interesting to note that the evident direction of this wave of emigration followed a north-westerly course from the Kirghiz Steppes, almost exactly corresponding to the normal north-easterly route. Four years later (in 1863) a much more important irruption took place, this time consisting probably of thousands of individuals, and very much the same route was followed; although, as might be expected in such a great rush of individuals, the wave spread wider and further, extending to Italy and the Pyrenees in the south, to Scandinavia and Archangel in the north, and throughout the British Isles to the Faroes. That these birds were attempting to found new colonies is proved by the fact that many of them endeavoured to breed in places that were best adapted to their requirements. In 1888, another and even more important wave of emigrating Sand Grouse spread over Western Europe, the particulars of which will still be fresh in the mind of the reader. This invasion was undoubtedly the most successful of all; and so well did the birds appear to be established that in our islands a special Act of Parliament was passed for their protection. There can be little doubt, however, that Western civilization will be too powerful a check on their colonizing efforts, and that each irruptic wave having the misfortune to flow west-

wards into Europe is doomed inevitably to destruction. The Rose-coloured Pastor (*Pastor roseus*) is another species that has evidently permanently increased its western range by very similar means; and even now vast flocks occasionally wander into new districts, like irruptions from congested areas seeking vent for their superabundant life. The observant ornithologist may often remark the occasional and often very extensive irruptions of much commoner birds, species less likely to arrest universal attention, that take place, and this unusual abundance is probably the result of a general exodus of surplus population from some overcrowded district. The irruptic emigrations of such remarkable birds as Sand Grouse or Pastors are noticed at once, whilst those of commoner species are apt to be overlooked, or their importance under-estimated, or even entirely ignored. The vast flights of Common Jays (*Garrulus glandarius*), for instance, that were noticed passing Heligoland in the autumn of 1882, for three days in succession, was probably an irruptic emigration of surplus population from a congested district. Similar irruptic waves of Goldcrests (*Regulus cristatus*) are occasionally remarked. Such instances as the above are more or less exceptional events at the present day, a period, as I have already remarked, of long-continued stability, primarily due to low eccentricity of the earth's orbit; but they enable us to form some slight idea of what Emigration must have been during epochs of great disturbance.

Instances of Chronic Emigration are not only as interesting, but even more numerous, and appeal all the more forcibly to us, because they are either actually in progress around us, or have only ceased during historic time. The evidence that many species of birds have quite recently extended their range, or are even in the act of doing so, is above the faintest suspicion of doubt, and in no small number of cases amounts to absolute proof. The Arctic Willow Wren (*Phylloscopus borealis*) at one time bred in North-east Siberia, and wintered in Burma and the Malay Archipelago, as might naturally be inferred from the locality of its summer quarters. But a slow and gradual emigration set in westwards across Siberia and Europe, and now this species actually visits Finmark in summer, but returns along the old routes of gradual dispersal to the ancient trunk fly-lines of the far East, which it follows to the accustomed winter home! The Siberian Pipit (*Anthus gustavi*) has emigrated gradually from the East in a precisely similar manner, and now its summer range is known to extend at least as far west as the Petchora Valley, in Russia, although its winter quarters are still confined to South-eastern Asia. The Rustic Bunting (*Emberiza rustica*) has extended its range even as far west as Scandinavia in summer, but returns to India and China to winter. Precisely the same kind of emigration has been taking place among West Palæarctic birds. The individual Willow Wrens (*Phylloscopus trochilus*) and Sedge Warblers

(*Acrocephalus phragmitis*), that are now known to migrate as far eastwards in spring as the valley of the Yenesay, return to Africa to winter! The Little Gull (*Larus minutus*) sends out pioneers as far as the Sea of Ochotsk, which return to the extreme south-west of Asia and to Africa to winter with the rest of the species. The Arctic Tern (*Sterna arctica*) is only found during winter in the Atlantic Ocean region, but in summer the range has been so far extended, that a great many individuals spread across Siberia to Behring Sea on the one hand, and across Arctic America to that sea on the other, where they breed in some abundance. Now the most astonishing part of this apparently anomalous distribution, is the fact that these various species go so far to winter quarters, when equally suitable regions might be reached without, in some cases, requiring a journey of more than a fourth of the distance. It seems little short of marvellous that the Rustic Buntings, for instance, breeding in Scandinavia, should return to India and China, and decline to accompany the vast number of European birds that migrate south to winter in North and West Africa, in whose company they have absolutely lived all the summer; or that the Sedge Warblers breeding in the Yenesay Valley should come west again to Africa, parting company with the myriads of Siberian birds, their neighbours of the summer, leaving them to journey down that great migration highway to India, whilst they laboriously push on to Africa, more than double

the distance! But the fact is, these little emigrant birds only know the way to that winter home, which has been their winter home from the remotest times, perhaps as long as their species has had existence; and they follow routes towards it along which their emigrations have extended. Their present fly-lines of migration then are inseparably connected with the direction of their past emigration, and indicate unerringly the road the colonists have followed from the central area of distribution, in opening out new and ultimately wide tracts of country for their surplus population.

But although we are able to trace with exactness the routes of recent emigration, the more ancient tracks that many species followed from common centres of dispersal have long been utterly obliterated. The present dispersal of obviously allied species, however, enables us to trace some of them almost with equal precision. The least used routes of Migration are the ones that best indicate the direction of ancient Emigration. They are routes, once easily and extensively followed, which from physical causes (especially submergence) have either been discarded altogether, or only followed by a few species. Most of these old routes would be entirely lost to us were it not for these lingering migrants across them, or the very obvious near alliance of the species along the route, where it still remains partially continuous, or the more distant yet equally certain relationship of forms at either end of that broken route.

I have already alluded to what I believe to be two very interesting ancient routes of migration, which in still more remote ages were obviously routes of emigration. One of these extended between India and South Africa across the Indian Ocean; the other as surely extended between Eastern Asia and New Zealand, by way of New Caledonia and Norfolk Island. The Orange-legged Hobby (*Falco amurensis*) is one of the last surviving instances of a fly-line across the Indian Ocean; but the number of species isolated in South Africa, allied to Indian species, testify to its ancient importance, and mark the route, the only feasible route of their emigrations, between these two countries. The only other land connection between India and Africa is by way of Arabia; but if we were to assume such to have been the route (and there is not the slightest evidence in its favour), we are confronted with the difficulty of transporting thoroughly tropical and south temperate species into northern zones, and then isolating them in South Africa without leaving a solitary trace or relic of their dispersal in the intervening country. Besides, some of the most interesting species, decidedly Oriental in type, are isolated in Madagascar, or on the Inter-Indian islands. Thus, in the Seychelles we find isolated species of such thoroughly Oriental genera as *Copsychus* and *Hypsipetes;* in Mauritius and Rodriguez species of *Palæornis.* It needs then no great stretch of imagination to recall those past ages, probably towards the close of the Tertiary Period,

when the Indian Ocean was studded with vast island groups between India and South Africa, forming fly-lines of migration between Asia and Ethiopia. Nor does it require any great perception to note how the emigrations of certain dominant species, compelled to increase their area in any suitable direction, by over-population or other equally potent causes, extended from island to island, until the two great countries were bridged by an Avian chain, of which many of the links still exist in sedentary birds isolated in South Africa, and of at least a few migratory birds that still continue to cross by a route, most of which has long disappeared beneath the waves!

Again, the Knot (*Tringa canutus*) and the Asiatic Golden Plover (*Charadrius fulvus*) are two of the last surviving instances of the important route of migration that once ebbed and flowed across the Pacific between Asia, New Zealand, and probably Antarctic land. Not only is this route still pointed out by the few migrants that continue to follow it, but its importance as a still more ancient route of emigration is confirmed in a singularly interesting manner by the present geographical distribution of various species of Ouzels. Emigration among the important group (Turdinæ) of which these birds form a considerable portion, has taken place on a very large scale. That the group is of Polar origin there can be little doubt, and its emigrations have spread far and wide over almost every portion of the earth's surface; not only

apparently in irruptic waves, but in steady chronic tides. From south to north, from New Zealand to Japan, stranded races, so closely allied in many cases as to be almost conspecific, on almost every important island or group of islands, point the direction emigration has taken, and suggestively indicate a much more continuous land surface between the Malay Archipelago, North Australia, and New Zealand than is now the case. Thus Norfolk Island is the home of *Merula poliocephala;* Lord Howe's Island that of *M. vinitincta;* New Caledonia that of *M. xanthopus;* the Loyalty Isles that of *M. mareensis* (Maré Isle), and *M. pritzbueri* (Lifu Isle); the New Hebrides that of *M. albifrons* (Eromanga Isle); the Fiji Islands that of *M. bicolor* (Kandavu Isle), and *M. tempesti* (Taviuni Isle); the Malay Archipelago that of *M. javanica;* Formosa that of *M. albiceps*. Here we have evidence of emigration on a very extensive scale; and testing the antiquity of the movement by the close affinities of the species, we are forced to the conclusion that it occurred at no very remote period. It seems to me that this emigration was not of a chronic character, the result of a gradual increase of population, slowly spreading from one island to another, for all of the species are now sedentary, but rather of an irruptic nature, caused by climatal change in a southern centre of dispersal; or even by the concurrent gradual or even rapid submergence of a continuous route of migration between New Zealand and Japan, during a glacial period, which

caused their present isolation on the various points which still remain above the ocean. But whatever the cause may have been is of little or no importance, the facts remain as a convincing proof of emigration on a wide and extensive scale.

There is also some evidence to suggest that this vast emigration of Ouzels, besides taking a direct northern course over the Pacific, also followed a route nearly due east across that ocean by way of the Low Archipelago and chain of islands that extends along the line of the Tropic of Capricorn to South America, where their descendants live and flourish in considerable numbers. Or we can account for the presence of these Neotropical Ouzels by an emigration from an Antarctic continent; one stream of emigrants retreating by way of New Zealand and the Pacific Islands; the other by way of Graham's Land, the South Shetlands, and Patagonia. Various faunal and floral links curiously enough bind New Zealand to South America, and the most obvious direction in which the connection once existed is by the now glaciated Antarctic continent. The fact that the Ouzels are not found in the Nearctic and Ethiopian region is very suggestive of an emigration from Antarctic latitudes, because Africa and North America were by far the most isolated from South Polar land; although they were undoubtedly the most important regions invaded by North Polar species during the Post-Pliocene Glacial epoch. The present distribution of the Snipes (*Scolopax*) appears to denote ancient emigrations by routes

which are in many places, if not absolutely identical, still almost the same as those followed by the Ouzels! So plainly are these past emigrations indicated by present geographical distribution, that one can almost venture to prophesy the discovery of new species of Ouzel and Snipe in that tropical chain of islands reaching across the Pacific, thus making the area of distribution of *Merula* and *Scolopax* continuous and complete.

Instances of small but recent avian emigration may even be met with in the British Islands. Such species, for instance, as the Song Thrush (*Turdus musicus*), Missel Thrush (*Turdus viscivorus*), and the Rook (*Corvus frugilegus*) are in a more or less acute state of emigration, gradually extending their area of dispersal as circumstances may arise favouring the increase. In Scotland these birds are gradually following the planting of trees; and I found it to be the invariable experience of competent observers in Skye, that soon after a plantation was formed, birds made their appearance therein which had never been met with in the neighbourhood before. The late Mr. Cameron of Tallisker (Skye) gave me many interesting details bearing upon the emigration of our common resident birds. The Partridge (*Perdix cinerea*) has followed the spread of corn cultivation in Scotland. The House Sparrow (*Passer domesticus*) has emigrated far and wide throughout the civilized world. This bird, according to Lyell, made its first appearance on the Irtish when the Russians

commenced to till the soil. About 150 years ago it spread up the Obb, and four years later had emigrated 500 miles still further to the east in this river valley. Thence it pushed onwards through the Yenesay to the Lake Baikal district, and is now abundant throughout Siberia, within these limits, wherever civilization has spread. Many instances might be given where various species have gradually become much more abundant, even in our islands. All this evidence tends to show that Chronic Emigration is far from being absolutely quiescent at the present day; rather must we presume that it is ever ready to break out much more acutely, even with irruptic virulence, whenever a stimulating cause may arise.

In many cases chronic emigration, or even irruptic emigration, may lead to the adoption of migratory habits, if the winters of an invaded district be too severe for constant residence therein. I have just alluded to the Song Thrush as a species in a state of chronic emigration in the British Islands. Even a very marked migration takes place during winter, which would lead us to infer that this species has only recently extended its range so far north. In Scotland this migration is even more pronounced, as the Duke of Argyll has most obligingly informed me. He writes from Inveraray: "At this moment our Song Thrushes have just returned. They almost all leave us for the winter season, although the Blackbird never

does. The Song Thrushes return regularly about the first week in February, or about this very date, the 10th. I did not see a single bird all the winter." That this dispersal into cooler areas has necessitated the adoption of regular migratory habits is absolutely certain; and in every known case of this kind of emigration we find that the migratory fly-lines follow the direction of that emigration, either to the point where it commenced, or to the point where the regular trunk line of passage leading to the usual winter quarters of the species may be joined.

From the above series of facts I think it will be reasonably evident that emigration is not only very closely associated with migration, but is even occasionally the means of its initiation. But emigration has also played other important parts in Avian Philosophy. The vast, wide-reaching influence of emigration on the Evolution of Species can never be sufficiently estimated. Everywhere we find evidence to indicate that emigration has been one of the most powerful aids to segregation. Without it the number of existing species would undoubtedly be enormously reduced; whilst the beautiful and wonderful dispersal of avian life throughout the world would have presented a very different aspect. The differentiation of vast numbers of species can be directly traced to emigration, often leading to the complete isolation of numbers of individuals, and bringing them under the influence of new conditions of existence,

which have stimulated and preserved variations in many different directions.

The great emigration taken by many Polar species, for instance, and caused by a Glacial epoch, often followed different routes from a centre of dispersal, causing a separation of the species into as many groups of individuals. In numbers of cases these several colonies remained isolated from each other sufficient time for the individuals of each to become differentiated from a parent form; in some cases so completely that when circumstances again brought each group together in a common habitat, they had not only lost the power to interbreed and produce fertile offspring, but had even acquired or developed various characteristics peculiar to each group. In this way emigration has directly led to the origin of new species. When the Polar ice banished every bird from the Arctic regions, emigration took place on a vast scale towards Africa, Southern Asia, and temperate and tropical America. The members of each species by no means kept together. Some followed a western course, others an eastern course; some emigrated down the coasts of Europe, others down the coasts of Asia; some down the Pacific coasts of America, others down the Atlantic coasts of that continent; or parties of emigrants were divided by the great mountain chains that stretch from north to south in the Nearctic and Neotropical regions. The result of this emigration and isolation is so indelibly stamped

upon the birds of the Palæarctic and Nearctic regions of to-day, that we can trace with absolute certainty not only the route many of those ancient bands of emigrants followed, but the ancestral forms from which they sprung. Probably few if any of the species living in the circumpolar region during Præ-glacial times survive at the present day. Some of them were doubtless exterminated; others became segregated into two or more species. Take, for instance, the great number of Palæarctic birds, that are represented in the Nearctic region by closely allied forms, or that are divided into eastern and western races due to emigration and isolation in past ages; or yet again the eastern and western species of Nearctic birds whose areas of distribution are separated by the Rocky Mountains, the result of diverging routes of emigration during the Glacial Epoch. In fact throughout the Northern Hemisphere the ornithological student is continually discovering fresh evidence of the vast influence of emigration on the origin of avian species in these regions. Many instances might be given in support of these statements, did space permit; many I have already recorded in *Evolution without Natural Selection*, a work to which I would refer any reader sufficiently interested to follow the subject further. Precisely the same vast emigration has taken place from South Polar areas due to glaciation.

Again, many island species of birds owe their origin almost entirely to emigration. From a

variety of reasons, as we have already seen, birds are apt to dispose of surplus population by irruptic emigration. Flocks of such birds we have every reason to believe occasionally wander long distances from their usual habitat, ready to settle in any favourable locality they may chance to discover. That such wandering birds sometimes cross wide expanses of sea is also certain; and it is to these nomads that the presence of birds on certain islands lying out of the track of normal migrants is almost if not entirely due. These birds settle in their new home; and owing to isolation from the rest of the species, any variations that may arise, excited primarily by changed conditions of life, are preserved through the absence of interbreeding, and in the process of time become constant characters. Thus we find in many islands endemic species of birds obviously descended from parent forms in adjoining but isolated areas, and to which they are more or less closely allied.

Islands located far from routes of migration are almost entirely populated, so far as birds are concerned, by fortuitous emigration. There is no regular influx of individuals, as is constantly taking place at the two seasons of passage on islands situated on or near a great route of migration, as for instance at the Bermudas, or even the British Islands, with the inevitable result of keeping the sedentary portion of the avifauna true by interbreeding. Hence we almost invariably find that the great proportion of the species are endemic, yet

obviously allied to forms on the nearest mainland. Distance is only of minor importance; for some of the most interesting island avifaunas in the world are located close to the continent which has fortuitously given them birth; whilst many remote islands favourably situated on routes of migration are remarkable for their paucity of endemic species. The Galapagos Islands, for instance, are situated on the Equator in the Pacific Ocean, about 600 miles from the West Coast of South America, in a calm region remarkable for the absence of gales. They are far removed from any present highway of migration, and no evidence exists to show any indications of an ancient route ever having crossed them. No less than thirty-eight out of the fifty-seven species of birds hitherto obtained on these islands are absolutely endemic. All the land birds (thirty-one in number) are peculiar except one species, the wide-ranging Rice Bird (*Dolichonyx oryzivora*); and more than half of these thirty species present such divergence of characters as to be classed in distinct genera. The Bermudas, on the other hand, lying 700 miles from the East Coast of North America, and 100 miles further from continental land than the Galapagos, are near one of the greatest routes of migration in the world, situated in an area where equinoctial storms of great violence and persistency prevail. More than 180 species of birds have been recorded from them, yet not one of these is endemic, and of the ten species that are resident, all are common on the

adjoining continent, and individuals are repeatedly arriving to mix and interbreed with the island individuals, thus preventing any possible differentiation which might and undoubtedly would soon occur through their isolation. In this case the effects of any fortuitous emigration have been rapidly eradicated, if ever they appeared, by the constant influx of wandering individuals from the adjoining route of migration. So long as this fly-line continues to be recognized by migratory Nearctic species, the Bermudas cannot possibly acquire any remarkable or specialized endemic avifauna.

Even the British Islands can furnish one or two instances bearing on this interesting subject. These islands are remarkably poor in endemic species, partly owing to their separation from continental Europe being so recent, and partly because they are situated on a great route of migration, which keeps the island individuals of almost every species well mixed with continental individuals, and thus by interbreeding checks any tendency to variation being preserved by isolation. Endemic British species of birds are therefore excessively rare. The Red Grouse (*Lagopus scoticus*) is certainly the most interesting, and may have been the result of a fortuitous emigration of Willow Grouse (*Lagopus albus*) from Scandinavia, or a colony of the latter left isolated on British moors by the submergence of land between the Orkneys and that country. Any way, the Red Grouse owes its specific distinctness to the fact that its continental

ally is sedentary in the sense of not crossing the sea. The St. Kilda Wren (*Troglodytes hirtensis*) is another instance. This island form of the Common Wren (*T. parvulus*) succeeds in retaining its distinguishing characteristics, not only because it is sedentary in St. Kilda, but because its island home is a long way removed from the usual fly-lines of any migrant Wrens that cross from the continent to our islands. This endemic race shows how rapidly variation can take place when its greatest check, the facility of interbreeding with the parent form, is removed. On the other hand, such slight local variation as is presented in the British form of the Coal Tit (*Parus ater britannicus*) and the Long-tailed Tit (*Acredula caudata rosea*) are prevented from becoming more specialized or constant by the regular influx of individuals from adjoining continental areas, which visit our islands and interbreed with these local forms. Again, Heligoland (with Sandy Island, a tiny islet of only some 250 acres area) has a wonderful record of no less than 396 species reputed to have been met with on its shores, but does not contain one endemic bird, because it is situated on another important route of migration. The British Islands, being one of the best examples known of recent continental islands, furnish wonderful evidence of the emigration of species. At a period no more remote than the latter part of the Post-Pliocene Glacial Epoch, nearly if not all their area was submerged to a depth of some 2000 feet, only our

highest mountains remaining above the sea in scattered rocky islets. This awful devastating submergence banished all or nearly all living things; so that from the period of their subsequent elevation the tide of emigration must have set in towards them in no uncertain stream, to people these islands with their present wealth of plant and animal life! Many bird emigrations to them led to migration, or increased the fly-lines of species; and these routes of migration then slowly formed are followed with amazing persistency down to the present time!

From the above facts we can form some idea of the vast importance of Emigration, not only in the dispersal and segregation of avian life, but in the periodical movements of birds. The great geological, geographical, and astronomical changes in past ages have driven birds to and fro across the earth and ocean; excess of population or invasion of competing races have despatched them from endless centres to every part of the world capable of supporting and nourishing them; whilst the results of their mazy peregrinations are indelibly stamped upon existing species, and much of the direction of these ancient emigrations are indicated by the present dispersal of birds over the earth's surface.

CHAPTER VI.

INTERNAL MIGRATIONS AND LOCAL MOVEMENTS.

Vertical Migration—Instances of, in India—Instances of, in Algeria—Not Confined to Endemic Species—Instances among Migratory and Sedentary Species—Vertical Migration among Mountain Species—Similarity between Vertical and Latitudinal Migration—Initiating Causes—Migration in the Southern Hemisphere—Scarcity of Southern Hemisphere Migrants to Northern Hemisphere—Important bearing on Migration of this Fact—Polar Breeding-Grounds—Law of Northern and Southern Migrations—Reversal of Polar Breeding Areas—Results on Migration—Comparative Examination of Northern and Southern Hemisphere Migration—Instances of Northern Migration from Southern Latitudes—Migrations of Various Petrels—Single Breeding of Migrants—Possible undiscovered Antarctic Breeding-Grounds—Migrants not Breeding in Northern Hemisphere—Neutral Zones of Non-breeding Birds—Isolation of Northern Types in Southern Hemisphere—Local Movements of Birds—Winter Migration—Importance of Local Movements in preserving Species.

In addition to the prolonged migrations that many birds undertake, there is an immense amount of Internal Migration and Local Movement in progress amongst others at certain seasons of the year. Some of these internal migrations are as regular as the more extended flights, follow certain routes, take place at appointed times. Indeed, so universal are the causes leading to migratory movement of some

kind, that the probability is, very few birds indeed can be regarded as thoroughly sedentary. Even in the lowlands of the equatorial regions, where the usual type of migration is unknown among the resident avifaunas, considerable movements take place according to season.

We will deal with the phenomenon of Internal Migrations first. These may be divided very naturally into two great groups, viz. Vertical Migration, or the regular passage of birds from the plains to the hills; and the Northern Flights of various species breeding in the temperate portions of the Southern Hemisphere, and whose order of progression is exactly the reverse of what takes place in the Northern Hemisphere. The amount of vertical migration is enormous, and is most prevalent in hot countries, although there is a very perceptible vertical movement even in such temperate districts as the British Islands and Scandinavia. Perhaps in no other country is vertical migration more pronounced or more widespread than in India. Here great numbers of species retire from the plains to the slopes of the Himalayas to breed, ascending thousands of feet above sea-level, and returning to the lowlands as the cold season approaches. The Common Woodcock (*Scolopax rusticola*) goes at least to an elevation of 10,000 feet to breed in these mountains, and winters on the plains. The movements of these birds are just as regular as those of species whose fly-lines extend for thousands of miles, although the altitude visited varies a good

deal in individual species. The same remarks apply to North Africa. Many birds there are regular migrants, coming up from the desert in spring, where they have been spending the winter in the various oases, and breeding on the slopes of the Atlas. Their fly-lines may be traced down certain valleys, through gorges, and from oasis to oasis, followed just as unerringly as those of birds whose migrations extend far across the sea.

I had the pleasure of observing two very interesting instances of this vertical migration whilst travelling in Algeria, one of which had hitherto escaped the notice of naturalists. This was the vertical movement of Tristram's Warbler (*Sylvia algeriensis*), a species that was originally discovered by Canon Tristram in the remote oases of the Sahara, and whose habitat was stated by that naturalist to be ".only in the southern desert." This region, however, is but its winter quarters, for in summer I found it distributed throughout the Djebel Aurés, from the plateau of Batna, 3500 feet above sea-level, up to 6000 feet near Oued Taga. The second species was the gay and lively Bush Chat (*Pratincola mousseri*), which Canon Tristram found in increasing numbers as he went south into the desert during winter; but in summer exactly the reverse conditions prevail, and I found it equally common from Batna up to 6000 feet, becoming less common on the lower and southern slopes of the Atlas to the oasis of Biskra, which is only 360 feet above sea-level. Again, the Chat (*Saxicola*

seebohmi), a species discovered by Captain Elwes and myself, is only known to breed at 5500 feet elevation in the Aurés, and doubtless winters in the oases of the desert. The Goldfinch (*Fringilla carduelis*) is another instance. I found this bird breeding in Algeria, where it is a resident, up to 4000 feet, and wintering on the plains. In fine, wherever mountains occur, it may be laid down as an almost universal rule that there is a considerable amount of migration taking place between their slopes and the plains. This rule, however, is by no means confined to species resident in those countries; for we find in a great many cases that some individuals of a migratory species wintering in southern lands and breeding in the Arctic or temperate regions, ascend mountains to such altitudes as render the climatal conditions similar to those prevailing in the higher latitudes to which the bulk of the individuals resort. This is a very remarkable and interesting fact, of which the following instances may be regarded as typical. The Dotterel (*Eudromias morinellus*) breeds on the tundras of the Arctic regions above the limits of forest growth, but a few individuals find a similar climate at high elevation in the Alps, and on the mountains of Great Britain and Scandinavia. A few Tree Pipits (*Anthus arboreus*) breed on the Alps and the Pyrenees, but the great majority migrate north in spring. The Redstart (*Ruticilla phœnicurus*) winters in North Africa, passes through South Europe on migration, and breeds throughout Central

and Northern Europe up to the Arctic Circle. A few individuals, however, ascend the mountains of South Europe to breed in the pine region. The Wheatear (*Saxicola œnanthe*) has a very similar range, but extending much further north; a few individuals ascend the highest mountains of South Europe to breed in the pine and birch regions. The Whinchat (*Pratincola rubetra*) breeds sparingly on the mountains of South Europe. The Black-throated Ouzel (*Merula atrigularis*) breeds in Central Siberia, and winters in Baluchistan, India, and West Turkestan; but many individuals ascend the Himalayas and the mountains of Turkestan to the pine region, where they breed.

We also find that in many sedentary species ranging, say from sub-tropical to north temperate regions, the individuals in the extreme southern and warmest limits of the range ascend mountains to breed, where they find similar climatal conditions as those individuals dwelling in the more northern and cooler portions. Hence, one section of the species is resident, the other portion has acquired migratory habits, although the journey is vertical instead of latitudinal. The Hedge Accentor (*Accentor modularis*) is one of the most familiar instances occurring to me. This species is practically sedentary, except in the extreme northern portions of its range (although even here it is said in some places to be resident), which extends throughout Europe south of lat. 70° in the west, and lat. 64° in the east. Everywhere in the extreme

southern limits of its range it retires to mountains to breed.

Much shorter yet equally interesting movements in a vertical direction are furnished by a great many endemic mountain species. Wherever the mountains are lofty enough to range from a tropic or subtropic zone at their base to a temperate or Arctic climate at their summit, we have numerous instances of vertical migration. In summer these birds ascend into the region that affords them the requisite climate during the season of reproduction, some of course going to much greater elevations than others, to the rhododendron, the pine, or the birch region, as the case may be, and descending with the approach of winter to a more genial climatal zone. Many instances of this kind occur in the Caucasus, the mountains of Turkestan, the Himalayas, the Andes, and elsewhere. In the Alps and the Carpathians, for instance, we find the Alpine Accentor (*Accentor alpinus*) an endemic species, which visits the highest summits to breed in the Arctic climate above the limit of forest growth, and just below the line of perpetual snow, retiring in winter to the lower valleys. The vertical migrations of some of the Rose Finches (*Carpodacus*) are precisely similar, some of these birds ascending in summer to an elevation of 10,000 feet, and wintering in the lower valleys.

From all these facts it will be seen that vertical migration is very similar to latitudinal migration, and that it is undertaken for purposes precisely the

same. Probably much of it was initiated in equatorial regions during periods of intense local glaciation; whilst many of these mountain migrants in more temperate zones may be the last survivors of the hosts of birds that were driven from Polar zones by the Post-Pliocene Glacial Epoch; remaining behind to breed in regions that were once on the immediate margin of the glaciers, and in their movements at the present day very clearly indicating the nature and extent of that migration that prevailed during the acute phases of Polar glaciation in past ages. Whilst other species, even other individuals, have gradually extended their northern flights towards that olden Polar Paradise, these have remained content with shorter pilgrimages; although, in every instance, it will have been remarked that the object attained (a similarity of breeding temperature) is precisely the same.

We now pass to the migration of birds in the Southern Hemisphere. Unfortunately we have many obstacles to contend with, and are placed at considerable disadvantage in our study of bird migration in this region. In the first place, the data on which any conclusions may be based are somewhat meagre, partly owing to the scarcity of any careful and intelligent observation, and partly owing to geographical peculiarities, rendering migratory movements not only few but exceedingly restricted, in comparison with the vast flights of northern species. Nevertheless migration in the Southern Hemisphere, as I hope ultimately to show,

is not only of intense interest in itself, but of vital importance as an indicating demonstration of physical mutations and biological changes as vast and far-reaching in their results as any that the Northern Hemisphere has experienced.

The apparently anomalous fact that very few birds breeding in the Southern Hemisphere during summer in the south are known to migrate north of the Equator to winter during summer in the Northern Hemisphere, is a profoundly important one—a fact which in reality is the key to the phenomenon of migration as it is practised during present time. Broadly speaking, every migratory bird throughout the world leaves a warmer climate or zone to breed in a cooler climate, either by ascending mountains until the altitude furnishes the degree of temperature necessary, or by visiting temperate or Arctic regions where similar conditions prevail. A vast number of species then pass from tropical climates to temperate and Arctic latitudes, probably because this area is much more extensive and suitable than the restricted mountain regions in lower latitudes. In these vast northern areas there is no lack of room, and an abundance of food, resulting in easier conditions of life, and consequent decrease in racial struggle for existence. But, as we have already seen, these Polar regions of avian Paradise are by no means eternal; banishment waits upon the bird world there, in the form of glaciation and the complete reversal of climate at either Pole in the course of equinoctical precession combined

with orbital eccentricity. The inevitable deduction from these clearly demonstrable facts is, that whichever Pole is passing through a period of mild climatal conditions and freedom from glaciation, the region round that Pole will be the great breeding area of birds whose migrations are latitudinal. Hence at the present time we have few birds undertaking a latitudinal migration during summer in the Southern Hemisphere, and possibly only one or two breeding sufficiently high in South Polar latitudes to bring them into the Northern Hemisphere to winter during our summer, as by the law that the further north a bird goes to breed the further south it goes to winter, and inversely, by inference, the further south a bird goes to breed, the further north it goes to winter, they undoubtedly would do. The reason for this is, that the now glaciated condition of the Southern Pole has destroyed the once fair Antarctic paradise, the Mecca of migratory birds during the ages the Northern Pole was labouring under its desolate burden of glaciation. At the present day conditions are exactly reversed. The Arctic and north temperate regions are free from glaciation, and furnish suitable breeding-grounds for these migrants, and as a natural consequence we find the progress of migration reversed, and birds come north to breed and go south to winter, as we during historic time have only known them to do, and as appears to us therefore the only normal procedure. Migration then in the Southern Hemisphere, as we

now see it, is but a fragment of the vast and regular passage that undoubtedly took place when the Antarctic continent—a region we must remember estimated to be six millions of square miles in extent, or twice the area of Australia—sustained and nourished avian life, and is precisely similar to that migration which took place during the Glacial Epoch in the Northern Hemisphere. Almost the only birds left in this region are those that bred in the lower or temperate zones, and, as in the Northern Hemisphere to-day, these species breeding in the lower zones are remarkable for the comparative shortness of their migration flights. Not only so, but many of the species now breeding on the outskirts of the glaciated southern continent, either penetrate to the Falkland Islands, Tierra del Fuego, the South Shetlands, and possibly Graham Land, or obtain suitable climatal conditions by vertical migration; these latter being species that may have lingered in the Southern Hemisphere long after the great Antarctic breeding-grounds had been closed.

It is a very interesting fact that the now prevailing migrations of birds in the Southern Hemisphere confirm the views above expressed. If these premises are true, we should not expect to find any extension of migration flight into the Northern Hemisphere during winter in the Southern Hemisphere. Neither do we, save in a few exceptional cases. Let us test the truth of our conclusions by a comparative examination of this

Southern Hemisphere migration, with what is taking place in the Northern Hemisphere. In the first place, we must not lose sight of the important fact that no non-glaciated land area of any great extent now exists beyond, say south lat. 55°, which contracts the zone of southern breeding-grounds to a latitude corresponding with that of Edinburgh and the Baltic in the Northern Hemisphere. It may be laid down as a pretty general rule, that birds breeding up to the limits of the temperate zone in the Northern Hemisphere, and wintering below the Equator, are few, and principally birds that visit the most northerly portion of that zone, especially Waders. On the other hand, the birds breeding in the Southern Hemisphere and wintering above the Equator are very few (so far as is at present known), because the south temperate zone does not extend far enough south. It is, however, a profoundly interesting fact that in South America and Australia, where this zone extends the furthest south, we find, as we should expect to find, the most northern Migration Flights, some few species being known to come up north to Brazil and New Guinea. The Patagonian Plover (*Charadrius falklandicus*) visits the Falkland Islands and South Patagonia in September and October to breed, and is known to migrate at least a couple of thousand miles north during the antipodean winter, which is just as important a flight as that of the Kentish Plover (*Ægialophilus cantianus*) from England to North Africa. The Falkland Dotterel (*Eudromias*

modestus) breeds in the islands whose name it bears, arriving in September and leaving in April, and its northern migrations extend at least 1500 miles to Uruguay, where it was obtained by Darwin. The allied race of this species (*Eudromias modestus rubecola*) visits Tierra del Fuego during summer to breed, and is known to migrate during winter for about 2000 miles north along the South American coasts. In the extreme South of Africa many species of Swallows and certain Cuckoos are all migratory, and leave the comparatively cool climate of that region during winter for haunts extending more or less towards the Equator, although the Flights are not perhaps so long as in South America. The Australian Swallow (*Hirundo frontalis*) breeds in Australia, and migrates north to the Equator to winter in New Guinea. It is an equally suggestive fact that several species of Petrel breeding on the borders of the glaciated Antarctic continent, some of the most southerly breeding of birds, regularly visit the Northern Hemisphere during our summer. So interesting and so vitally important to the views here expressed are these northern migrations, that it will be necessary to note a few of them in detail. One of the best known Petrels that comes north during winter in the Southern Hemisphere is Wilson's Petrel (*Oceanites wilsoni*). This bird is known to breed on Kerguelen Island, one of the few islands that lie on the borders of the Antarctic continent, and may possibly do so on other land even nearer the South Polar region. During winter

it migrates north across the Equator to the northern coasts of the Indian Ocean; in the Atlantic, as high as the West Indies, New York, and the British Islands (where flocks are occasionally observed); in the Pacific, as high as Peru and Chili, and possibly much further. From May onwards this Petrel is one of the commonest birds met with in the Atlantic by the various Liners that cross from Europe to the States. Wilson's Petrel arrives at its Antarctic breeding-places in November, and stays for a period of about five months until the young are safely reared, then migrates northwards to enjoy a second summer in the Northern Hemisphere, but not to breed. Our second instance is that of the Sooty Shearwater (*Puffinus griseus*), whose only known breeding-place at the present time is the Chatham group in nearly the same latitude as Kerguelen, but in the South Pacific. It migrates northwards after the breeding season, and has then been met with as high in the Northern Hemisphere as the coasts of Newfoundland, Labrador, and Greenland, the Faroes, and the British Islands; whilst in the Pacific it is known to range as high as California. Our third instance is the Collared Petrel (*Œstrelata torquata*), a species breeding in the New Hebrides, 2000 miles south of the Equator, which also comes north to winter, and has been obtained off the British coasts so recently as November 1889. That this species is thoroughly a Southern Hemisphere one seems proved by the fact that this latter example *was in moult*. Another

instance is furnished by the Cape Petrel (*Daption capensis*), a species said to breed on South Georgia. Now it is all nonsense to attempt to explain these northern migrations away by suggesting that breeding-grounds of these birds remain yet to be discovered in the Northern Hemisphere. The migration of a Petrel from the Island of Desolation, as Kerguelen is otherwise called, to the British Seas, is no more wonderful than the flight of a Knot from Grinnell Land to South Africa. So far then from being in any way anomalous, these northern migrations are perfectly regular, and just what we ought to find if our views on Migration are correct. It must also be remembered that Petrels, the most southerly breeding of birds, and consequently the most northerly ranging during the antipodean winter, are very similar in appearance to northern species, apt to be overlooked, and are seldom shot at a season when the collecting of sea birds in British waters is forbidden by law. Again, our own Petrels breeding furthest north retire in precisely the same way to far southern latitudes, where they are even less likely to be observed, being so thoroughly oceanic in their habits. The Great Shearwater (*Puffinus major*), for instance, breeds as high as South Greenland, and has been obtained near Cape Horn, although naturalists whose knowledge of Migration Philosophy seems none too extensive, have sought to cover the record with discredit, and to imply an error in identification! The Dusky Shearwater (*Puffinus obscurus*) breeds

on the Bermudas, Bahamas, Madeira, &c., and wanders south in winter, even as far as Australia and New Zealand. It was my intention to devote a chapter entirely to Ocean Migration, but the want of reliable information has reluctantly compelled me, for the present at any rate, to remain silent. Migration Flight, however, seems just as regular and important among oceanic birds as in more terrestrial species, and to be governed by the same laws.

These northern flights of Southern Hemisphere species may yet be found to be more numerous when the ornithology of the Neotropical region especially is better known. At the present time it is one of the least known regions in the world. In South Africa and Australia, as we should naturally expect, the northern migration in the antipodean autumn is the most restricted, for there we find the least difference between an extended temperate zone and the Equator.

It is owing to these circumstances that in northern latitudes we observe very few migratory birds during summer from the Southern Hemisphere from an Antarctic region, giving up their little lives to idleness and enjoyment, side by side with Northern Hemisphere species busy bringing up their young and full of family cares—an anomaly that may be witnessed everywhere, in more or less frequency, during the antipodean summer, when our migrants are away from us, and Southern Hemisphere birds are breeding. These migratory birds breed only

once in the year, either in the Northern Hemisphere or in the Southern Hemisphere; and the alleged instances of certain northern species breeding in South Africa during their winter sojourn are entirely unsupported by reliable evidence. There is one circumstance, however, bearing on this question, to which I should like to call attention, with the view of obtaining more definite information. Several species of birds known to breed in the high north have often been observed in flocks during summer in that region. Is it fair to presume in every case, as we are apt to do, that these flocks are young non-breeding birds, perhaps born the previous year? May it not be possible that some of these birds have bred in undiscovered Antarctic breeding-grounds, and are spending the period of the southern winter in corresponding northern latitudes? I think more definite information is required as to these gregarious individuals, seeing that we have some not altogether untrustworthy evidence of such thoroughly Polar species as Bonaparte's Sandpiper (*Tringa bonaparti*), breeding on the Falkland Islands; the Eastern Golden Plover (*Charadrius fulvus*), breeding in New Caledonia (the only records, June and July, of this species at Heligoland are very suggestive); and the Turnstone (*Strepsilas interpres*), breeding on Lord Howe's Island (young partially fledged have been captured in this island); whilst the eggs of the Curlew Sandpiper (*Tringa subarquata*), a species that goes as far south as Australia to winter,

are entirely unknown. Is it possible that the Knot (*Tringa canutus*) breeds anywhere in the Antarctic regions? We know that this bird passes to and fro between the Polar regions of either hemisphere in vast numbers, and still no breeding-ground has yet been discovered in the Arctic regions in any way proportionate to those numbers. Mr. Hudson in his lately published valuable work, *The Naturalist in La Plata*, remarks the appearance of certain Northern Waders on the Pampas (notably *Limosa hudsonica*), at a season which strongly suggests their having bred in Antarctic latitudes. Again, it is quite possible that many individuals of species that winter in South Africa and breed in Europe, as the Swallow (*Hirundo rustica*), the Willow Wren (*Phylloscopus trochilus*), and the Sedge Warbler (*Acrocephalus phragmitis*), for instance, might visit the Northern Hemisphere in our summer, after having bred in South Africa, but do not attempt to breed again, and be overlooked. No one would suspect such a thing to be taking place, and yet it is not impossible, if not very probable. We should expect to find this state of things prevailing, if at all, in the Northern Hemisphere, on the southern limits of the summer area of dispersal of these species; in Algeria, for instance, where curiously enough all three of the above-named birds are found throughout the year. Probably somewhere in Central Africa these birds may be found all the year round, yet never breeding in those equatorial districts. It is also a curious fact that the Quail

(*Coturnix communis*) is a spring visitor to and breeds in South Africa; and this seems to confirm the view that there is somewhere in Central Africa a Neutral Zone of non-breeding birds of various species, part of which come north to breed in the Palæarctic region, and the other part go south to breed in the temperate portions of the Ethiopian region. As yet there is no evidence whatever to show that the breeding area of the Quail is continuous. The Black-necked Grebe (*Podiceps nigricollis*) is another good instance. From what we have already observed, I strongly suspect that this Neutral Zone will eventually be discovered; it is postulated on this evidence, especially when we bear in mind that there are no localities suitable for the breeding-grounds of decidedly temperate species in equatorial Africa. Brazil and the Malay Archipelago may also contain such Neutral Zones. These, however, are questions connected with the science of Migration that must be left to future research to solve. I allude to them, because it seems to me they suggest a way to great discoveries.

There is one other point connected with migration in the Southern Hemisphere which tends to confirm the views previously expressed on this subject, and that is the isolation of many species of birds in the Southern Hemisphere obviously nearly allied to northern types. This is just what we should expect to find upon the Antarctic regions becoming glaciated. Most if not all of these upland species

in the temperate regions of the Southern Hemisphere are birds banished by the South Polar Glacial Epoch; many of them are sedentary on the mountains; others have acquired regular habits of vertical migration, just as we have seen is the case with many species in the Northern Hemisphere.

We thus see that the study of Migration in the Southern Hemisphere is a very important one, for it enables us to test the soundness of the views we have expressed, and tends to confirm them in no uncertain way. When migration has been studied in this part of the world as diligently as in the Northern Hemisphere, and we have consequently the same abundance of material from which to make deductions concerning it, the nature and purpose of this grand and important avian movement in the Antipodes will not be found to differ in any important respect from that prevailing in the opposite hemisphere.

We now pass to the second portion of the subject of the present chapter, the Local Movements of Birds. These local movements are almost if not entirely confined to the season of winter in the temperate zones, and to the dry season in the torrid zone of the earth. They are indulged in not only by endemic species in each of these great regions, but by migrants whilst sojourning in their winter quarters. Probably the only cause of these local movements, wherever they occur, is due to failure of food supply. Although these movements have been little studied by naturalists, especially in

the warmer regions of the world, we have abundant evidence that they are not only very common, but strongly marked. Thus even in the tropics, where life of all kinds seems perennial, birds wander about at stated periods in quest of favourite food. We have the evidence of naturalists who have noticed these errant wanderings of species in tropical forests, that various birds only appear in certain districts during the flowering or fruiting of certain trees. This has often been remarked in the case of various Humming Birds and Parrots: "When the parasite plants of Guiana," says Waterton, "have come into full bloom, then is the proper time to find certain Humming Birds, which you never fall in with when these parasites are only in leaf. I have sought for them whole months without success, until the blooming of the parasite plant informed me that I need labour in vain no longer." Further, it has repeatedly been noticed that many species of birds in the tropics are distributed over certain parts of the area of their dispersal according to season; coming to some districts to breed, and retiring to others as soon as that duty is completed. During the hot season in some countries great areas are so burned and scorched that many birds are compelled to migrate for some distance to other areas, where more suitable conditions of existence are presented. The distance travelled, the routes followed, and the exact periods of absence, have been little recorded; but the broad fact remains that a movement takes place. Probably very few

species in any part of the world remain absolutely stationary throughout the year; everywhere important changes take place, and birds have to adapt themselves to those changes, which in most cases involve a temporary removal from one district to a more or less remote other district. In countries where vast flights of locusts are continually wandering to and fro, birds of many species follow in their wake to prey upon these insects; whilst in South Africa, Mr. Seebohm observed a most interesting local movement of certain birds in search of roasted grasshoppers, destroyed by the great prairie fires. Large flights of Pratincoles (*Glareola melanoptera*), and numbers of Ruppell's Lapwings (*Vanellus melanopterus*), and Birchell's Coursers (*Cursorius rufus*), follow these fires from one district to another, to feed on the abundant fare they provide. The various local movements of the ubiquitous Rice Bird (*Dolichonyx oryzivora*) of North America are equally interesting; as are even those of our own House Sparrow (*Passer domesticus*). This latter bird is subject to much local movement during summer and autumn, and wanders far and wide in flocks in quest of grain. The Lapwing (*Vanellus cristatus*), the Snipes (*Scolopax*), especially the Woodcock (*Scolopax rusticola*), and the Sky Lark (*Alauda arvensis*), may be instanced amongst numerous others as British species that wander about in winter, often in considerable numbers, in quest of food. Birds of the Pigeon tribe (COLUMBIDÆ) are notorious wanderers; so are the

various berry-eating species, such as the Fieldfare (*Turdus pilaris*) and the Missel-Thrush (*Turdus viscivorus*). All these birds undertake journeys of varying length during winter in quest of food—movements not exactly of a migratory nature, yet sufficiently regular and important to require notice in connection with the usual migration flight of birds. Again, birds of far-extending and regular migration wander about their winter quarters after their long Flight is done, visiting this district and that according to the abundance of food.

It is very difficult to classify these Local Movements, or to determine which are regular migrations and which are not. It would seem that a certain amount of local migration is actually in progress even during mid-winter, as the evidence gathered by the Migration Committee of the British Association, by Gätke on Heligoland, and other observers, is absolutely undeniable. Nor is it confined to the colder regions of the world, for instances are not wanting of Winter Flight in the tropic zones. It is evident that a considerable amount of Winter Flight takes place over the North Sea, to and fro between the Continent and the British Islands, especially among Waders and aquatic birds; and this movement is probably due entirely to failing food supply, or severe weather in either district respectively. A long spell of severe weather sends great flights of birds from one district to another where milder conditions prevail. I have repeatedly observed instances of this winter migration during severe

weather. During long-continued snowstorms all our Sky Larks have vanished; frosts of long duration invariably banish the Redwing (*Turdus iliacus*), the Snipes (*Scolopax*), and other ground-feeding species; failure of the berry supply will initiate a local migration of all birds that chiefly depend on it for subsistence. On the other hand, during severe weather flocks of other birds have visited us that seldom or never do so under ordinary circumstances. We shall enter more fully into this in a later chapter.

From the above series of facts we may learn that few birds are really stationary throughout the year; that it is rather the exception for a species to be absolutely sedentary. Again, many if not all young birds are great wanderers, driven from their birth-place by their parents, or deserting it voluntarily as soon as parental care becomes unnecessary. One important result of all this Local Movement is, that it serves to keep individuals well mixed together, and insures that all-necessary cross-breeding, or "mixed marriage," which is so essential to the well-being and even preservation of each and every species.

CHAPTER VII.

NOMADIC MIGRATION.

Nomadic Migration most prevalent in Cold Regions—Resident Birds in the Arctic Regions—The CORVIDÆ as instances of Nomadic Migration—The Pine Grosbeak and the Shore Lark—Snow Buntings—Arctic Grouse—Ducks and Gulls—Nomadic Migration in Antarctic Regions—What Nomadic Migration teaches—Birds of Short Migration Flight most closely allied to Nomadic Migrants—Claim of Nomadic Migrants to Generic Rank—Absence of Representative Forms of Nomadic Migrants in the Southern Hemisphere—Geographical Distribution of the Shore Larks.

THERE is another class of migrants it now becomes necessary to notice, birds whose periodical flights are too important perhaps to be classed with mere local movements, yet too irregular to come within the scope of any migratory movement hitherto described. The species indulging in this peculiar kind of migration are the Nomads of the Avian world, the restless wanderers with no settled or definite winter home. Just as the nomad savage wanders to and fro about his wilderness, pitching his camp here one day, miles away the next, according to his ever-fluctuating supply of the bare necessaries of life, so do these vagrant birds pass the non-breeding season in quest of food. We

find the greatest amount of Nomadic Migration prevailing among birds peculiar to the coldest regions of the earth, either on mountains or in high northern latitudes—species whose supply of food is not curtailed by any decrease of temperature, able to live throughout the long Arctic winter wherever the snow does not absolutely cover the various substances on which they live.

These nomadic migrants very forcibly show that Want of Food was one of the great initiating causes of regular migration in autumn, just as High Temperature was probably the great initiating cause in spring. So long as food can be obtained, most birds show great reluctance to adopt a migratory habit in autumn; therefore throughout the Arctic regions, except, perhaps in the Polar zone, some birds may be found all the winter through wherever food can be obtained. No insectivorous birds are known to winter above the isothermal line of prevailing snow and frost at that season, but many species of birds whose food consists of buds, twigs, seeds, and berries; or that subsist on any carrion or refuse; or that prey upon these other birds themselves, habitually remain near this snow-clad and frost-bound area, moving about just as the food supply may fluctuate, sometimes wandering south during a spell of unfavourable weather, but hastening north again as easier climatal conditions recur.

Of course the birds that habitually winter in the Arctic regions are comparatively few, for the simple reason that the great majority of species that visit

this area are either exclusively insectivorous, or subsist on a variety of animal food that cannot be obtained during winter. Some of the most interesting instances of nomadic migration are presented by the various species of CORVIDÆ that frequent the Arctic regions. The Raven (*Corvus corax*) keeps to the extreme north as long as food can be found, and wherever a village or settlement furnishes any regular supply of refuse, will brave all the rigours of an Arctic winter with impunity. The Siberian Jay (*Perisoreus infaustus*), one of the most warmly clad of all Arctic birds, keeps to the northern forests, wandering about to the more open and cultivated districts during winter or unusually severe weather, returning again as soon as sufficient food can be found. The Magpie (*Pica caudata*) and the Nutcracker (*Nucifraga caryocatactes*) dodge about their Arctic haunts throughout the winter, wandering hither and thither, and frequenting the villages and the post-roads to pick up a living, retiring to their more accustomed haunts as soon as the weather permits. None of these birds are migratory in the strict sense of the term; neither, however, are they by any means stationary; they are birds at the mercy of circumstances—wanderers and nomads, either becoming gregarious at the approach of winter, or remaining solitary or in pairs. The Pine Grosbeak (*Pinicola enucleator*) is another thorough nomadic migrant. It lives in summer in the more open forest districts of the Arctic regions; in winter it gathers into flocks like other

Finches. These flocks of Grosbeaks then wander far and wide according to circumstances, and though their southern migrations occasionally extend as far as the British Islands, France, and Hungary, there is no southern locality to which they regularly resort in winter, sometimes appearing in one, sometimes in another, just as the weather may affect their movements. Their stay, even when they do happen to visit these lower latitudes, is short and fleeting, and a northern migration commences as early as climatal conditions permit. The Shore Lark (*Otocoris alpestris*) is another Arctic nomad with no regular winter quarters, wandering about at that season spending its time wherever it can find food. Sometimes it wanders to the British Islands, and there is evidence to show that its visits are gradually becoming more regular, and the bird itself more numerous. This may indicate some change in higher latitudes affecting this species, necessitating more regular passage, a fact from which we may learn how readily a Nomadic Migration may develop into regular Passage if the causes are intensified.

We have many of these Nomadic Migrants that pay us uncertain and irregular visits, appearing in the British Islands during some winters, and never being seen again perhaps for years in the same abundance. Some of these nomads are more regular in their appearance than others. Scarcely a winter passes, for instance, that does not bring Snow Buntings (*Emberiza nivalis*) in varying numbers;

but the winters are very few during which we see the Pine Grosbeak. The Snow Bunting thoroughly deserves its name; it is perhaps the very first Passerine bird to penetrate into the higher Arctic regions with the return of spring, long before the snow has melted, or winter relinquished its iron grasp. As soon as the northern peasants begin to throw manure on their snow-clad fields, the Snow Buntings, previously hovering on the very edge of the snow-wreath, make their appearance; and although later snow-storms may banish them, again and again they return until winter is finally conquered, and the south wind brings sudden summer on its wings. As a rule, the endemic forest birds of the Arctic regions travel the shortest distances south, and very few of these birds have ever visited our islands. They are nomadic enough in their northern forests, but are rarely, if ever, driven from them to any great distance. The three species of northern Grouse, the Capercailzie (*Tetrao urogallus*), the Black Grouse (*Tetrao tetrix*), and the Hazel Grouse (*Tetrao bonasia*), inhabiting forest districts, wander about more or less during winter, but rarely if ever undertake any migration even of a nomadic character. The Willow Grouse (*Lagopus albus*), however, is a nomadic migrant in very cold areas, in summer frequenting the moors, like its congener the Red Grouse (*Lagopus scoticus*), of the British Islands; but in winter, when the tundras are several feet deep in snow, a migration is undertaken to the nearest forests, where the birds subsist on buds,

shoots, and pine-needles. I have known the Red Grouse make similar nomadic movements during heavy snowstorms, wandering miles from the moors, and even visiting farmyards and towns. Again, many of the Crossbills (*Loxia*) are typical nomadic migrants, having no regular season of passage or route of flight, wandering up and down as it were on the fringe of winter, now north, now south, in sympathy with each recurring change. Various species of Arctic Ducks (ANATIDÆ) and Gulls (LARIDÆ) are also good examples of this nomadic migration. Many of these birds never wander much south of open water during winter, unless compelled to do so by violent gales, ice-floes, and snowstorms. Steller's Eider (*Somateria stelleri*) and the King Eider (*Somateria spectabilis*) breed on the coasts of the Arctic Ocean, and the adult birds rarely come further south than where they can find open water during the long Polar winter; young birds, however, as is customary, wander further south, but never more than in a nomadic fashion. The Ivory Gull (*Pagophila eburnea*), the Snow Bird of the Arctic navigator, is another of the few resident species in the Polar zone, and its nomadic migrations are short, irregular, and uncertain. It lives amongst the eternal ice, and its omnivorous tastes enable it to pick up a sustenance in regions where most other creatures would inevitably perish. The Little Auk (*Mergulus alle*) is very similar in its movements. Its grand head-quarters are the dreary coasts of Spitzbergen (although it breeds in

suitable places throughout the extreme North Atlantic), where it is a partial resident, but numbers wander about a good deal in winter; and at that season it occasionally appears off the British coasts as a nomadic migrant.

The phenomenon of Nomadic Migration has been little studied in the Antarctic region; but there can be little doubt that it exists among the few peculiar species of birds that dwell on the borders of the glaciated South Polar lands. We cannot expect to find it so frequent or so marked a movement as in the Arctic regions, for obvious reasons, still the movement would well repay careful study, for I am of opinion that it throws much light on the origin of the more regular and extended migrations of birds.

The facts to be derived from a study of Nomadic Migration are of great value in assisting us to understand the origin of regular migration. Many of these nomadic migrants are probably descendants of those species that dwelt on the fringe of the glacial ice during the Post-Pliocene Glacial Epoch, the birds that wandered least from their devastated Polar haunts. There is not a single trace of their migrations ever having been Inter-Polar. In their wandering movements during present time they are profoundly interesting examples of migration in its incipient stage; they illustrate very vividly the rudimentary portion of that grand migration flight which now takes place almost from Pole to Pole. That some few birds remained in as high latitudes

as possible, even during the periods of greatest glacial intensity, seems very probable; just as round the margin of the glaciated South Pole we now find a few birds—last relics, we are compelled to regard them, of that rich and abundant Antarctic avifauna that dwelt round the Southern Pole in long past Eocene ages, and which was scattered north probably by a Post-Eocene Glacial Epoch. From Nomadic Migration we can gradually trace the movement into short but Regular Passage; and thence through every gradation to those long extended flights which we justly look upon with admiration and with wonder. These nomadic migrations represent incipient migration in the past, which never developed in these species or their ancestors to any greater extent than what we now witness; but, as we have already seen in a vast number, in the great majority of others it gradually became a function of the highest importance.

It is also worthy of remark, that the species performing the shortest regular migrations are closely allied to these nomadic migrants. There are few, if any, wide-ranging migrants among the Crows (Corvidæ), or Finches (Fringillidæ), Ducks (Anatidæ), or Auks (Alcidæ), or Gulls (Laridæ), unless belonging to different genera, which indicates more distant relationship. This fact, so far as it goes, is one very good reason for placing such thoroughly Arctic and isolated species in genera to themselves, in spite of the remonstrances of some naturalists, who always seem to think that a genus cannot be

a natural division unless it contains a good round number of species. If the species are few, that is no reason for lumping them into one or two genera, at the cost of concealing some of their most interesting features. Thus the Shore Larks fairly claim distinction from all other Larks, under the generic name of *Otocoris;* the Grosbeaks from all other Finches under that of *Pinicola;* the Eider Ducks under that of *Somateria;* the Little Auk under that of *Mergulus;* the Gulls under *Pagophila*, *Glaucus*, and *Rhodostethia.* In my opinion, if a genus illustrates or implies any important fact, either geographical or biological, it ought to be retained, even if the species it contains are few.

It might also be remarked of these nomadic migrants, that none of them are represented by closely allied forms in the Southern Hemisphere, and many are exclusively Arctic, a fact of great significance, indicating very restricted migratory movements through all Avian time, and probably confined close to the limits of glaciation. The geographical distribution of the Shore Larks (*Otocoris*) or the Waxwings (*Ampelis*) illustrate this. I will select the former genus because it seems the most anomalous, and yet after all it is not abnormal in any respect. All the Shore Larks are nomadic migrants, or actually sedentary, and number six more or less clearly defined species or races, all obviously very closely allied. Probably they formed one circumpolar species previous to the Post-Pliocene Glacial Epoch. Driven south by the advancing

glaciers, they were ultimately isolated in several colonies, some in the Nearctic region, some in the Palæarctic region. What led to their ultimate specific distinction we need not stay to inquire, because that does not bear on our present object. What I want to show is, that various species of Shore Lark are left isolated along the line which probably marked the small limits of their emigration during this Glacial Epoch. Two species occur across Central Asia from Palestine to China (*Otocoris penicillata*,[1] and *Otocoris longirostris*); one is an inhabitant of North Africa and Arabia (*Otocoris bilopha*); two inhabit the New World, one in the Northern United States (*Otocoris occidentalis*), and one in the Southern States, Mexico, and Central America (*Otocoris chrysolæma*). The Common Shore Lark (*Otocoris alpestris*) has succeeded in becoming circumpolar once more, as its common ancestor was in Præ-glacial times, and occupies the belt of country above its more southern representatives. If the limits of glaciation, as demonstrated by actual geological evidence, are followed round the Northern Hemisphere, we shall find these races of Shore Lark left on its extreme margin, nomadic migrants then as now!

[1] Four examples of this species have within the past year or so been obtained in Bosnia.

CHAPTER VIII.

THE PERILS OF MIGRATION.

Mortality amongst Migrants—Dangers of Migration—Fatigue of Migration Flight—Birds at Sea—Arrival of Exhausted Migrants—Effects of Sudden Gales and Storms—Choice of Sea Routes—Enemies of Migrants—Attraction of Light-houses and Light Vessels—Influence of Fog-horns on Migrants—Migration Streams visiting Lights—Telegraph Wires and Migrants—Mortality amongst Woodcocks—Instances of Striking Force of Migrants—Migrants losing their Way—Instances of Abnormal Migrations in British Islands—Instances in other countries—Abnormal Migration at Heligoland—Gätke's *Die Vogelwarte Helgoland*—Heligoland compared with British Islands—Comparative Table of Abnormal Migrants—Coincidence of Route of Abnormal Migrants — Effects of High Rate of Mortality among Migrants.

The Migration of birds is beset with dangers and full of perils. It would scarcely be possible to over-estimate the mortality among birds of passage directly due to migration. One very significant proof of this great mortality is presented in the fact that of the immense numbers of birds flying south or west in autumn, only a very small percentage come north or east again in spring! Most

people have remarked the great gatherings of Swallows, Martins, and Swifts, just previous to migration in autumn, yet where do we see such similar multitudes in spring? The majority of these birds are young ones, neither so strong of wing nor so robust of frame as their parents, and it is among these that the highest mortality is reached. The death-rate of a large town standing at say fifty or sixty per 1000, creates something like a panic among its human inhabitants; but there can be no doubt whatever that the death-rate among birds on migration reaches ten times that amount per 1000, and during exceptional circumstances very much more! From the moment that a migrant bird sets out on its journey it is exposed to quite a new set of dangers, whilst many other ordinary perils of its existence are very much intensified. From one end of its fly-line to the other successive dangers surround it, and enemies of every kind have to be eluded. Migration then, instead of being a pleasant path in the wake of retreating summer or in the van of advancing spring, is the most fatal undertaking in the life of migrant birds, and few there be that survive it.

The Perils of Migration may be divided into three important classes, viz. those arising from Fatigue, due to the mechanical portion of migration flight; those arising from the Natural Enemies of each species; and those arising from Blunders and Fatalities on the way. Probably the first class of perils is the most fatal one; a journey with little

rest by the way of even a couple of thousand miles, is a great strain on the endurance, especially of small Passerine birds; whilst a sea flight of, say 300 miles, with no opportunity for rest of any kind, and in many cases not even the chance of snatching a mouthful of food *en route*, must tax these tiny migrants to such an extent that only the strongest survive the journey. Of the countless thousands of birds that perish during migration, by far the greater number probably succumb at sea. Many instances are on record of great numbers of drowned migratory birds being washed ashore, especially after stormy weather. Some of these tired migrants save themselves by getting a chance rest on some passing ship, but the majority, especially when flying by night, quietly drop into the remorseless sea and perish! I have seen the Nightingale (*Erithacus luscinia*) rest on a steamer in mid-Mediterranean, as well as the Turtle Dove (*Turtur auritus*) and the Quail (*Coturnix communis*), all being remarkably tame, the former perching on the soldiers lying asleep on deck. These birds were crossing from North Africa to Europe towards the end of April, and only remained a short time with us, probably because we were steaming nearly due south, and therefore taking them out of their way. Had there been no friendly vessel within sight on which to rest, none of these birds probably would ever have reached the European coast.

The number of birds met with in the Atlantic, at varying distances from the British coasts, is very

interesting, and gives us some idea of this cause of mortality amongst migrants. The following extract from the *Report on the Migration of Birds*, during 1880, communicated by Mr. Robert Gray, will be read with interest :—

"The ship *Rutland* of Greenock, Captain Roy. When about 400 miles on this side of Newfoundland, during continued heavy gales from the east, Captain Roy observed numbers of birds taking refuge, on the 20th September. He had had head winds all the way home to England, and birds more or less numerous round the ship till the *25th October*. When he was 400—500 miles from Ireland, a violent storm arose, and blew prodigious flocks of birds before it. The deck and rigging were covered. Many died, and many were killed and used as food. The survivors, after staying a few days, were carried off by the force of the wind. Captain Roy observed one Robin, lots of Linnets, Snipe, Thrushes, Wagtails, etc. Heavy rains accompanied the storm." Mr. Gray continues : "My brother-in-law, on his way to Boston in one of the Cunard steamers, saw a Jackdaw and a Starling come on board on Oct. 23rd, during a gale from the east, when 550 miles from the Irish coast, easterly winds having prevailed for several days. On Oct. 24th, 850 miles from land, one Starling perched for a few minutes. A small bird, like a Linnet, hovered about the rigging but did not perch. One Water Rail was captured and detained ten [? two] days, 1200 miles from land, and two

Sandpipers. . . . When about 1080 miles from Ireland two Crossbills flew on board. Both were captured."

The arrival of a flock of migrants on the coast in a more or less exhausted state is some indication of the loss at sea. Only the strongest have survived the stormy passage, and even many of these are so tired and worn out as to allow themselves to be taken in the hand. On several occasions I have had the good fortune to witness an arrival of Goldcrests (*Regulus cristatus*), on the east coast of England. Before sunrise on the chilly late October mornings, I have seen the stunted thorn-bushes on the dunes or links for miles along the coast swarming with these tiny creatures—the smallest migrant in the entire Palæarctic region. Some have been much more exhausted than others; some have actually rocked to and fro with weakness as they sat upon the twigs; but the more robust ones were feeding eagerly, and some even indulged in song!

Birds seldom commence an extended migration flight, especially across the sea, until the weather is favourable; but a sudden change of wind, a gale, or a rain- or snow-storm, or a heavy shower of hail, frequently overtakes them, and beats and chills the very life out of all but the strongest. Even aquatic birds, able to drop on the water and rest whenever they may feel the inclination to do so, are often overtaken by gales, and blown long distances out of their way, even far inland. Small wonder then that

a gale or a storm proves fatal to migrating land birds, many of them frail of form and constitutionally weak and feeble. We can therefore readily understand why it is that migrants decline to make any very extended flights across the sea, except the most fleet-winged and robust. On every known sea-route of migration it has been remarked that birds, especially small terrestrial species of comparatively feeble flight, choose, invariably, the easiest way across, where choice is possible. Some of these sea passages are, of course, wider than others, but every available assistance is made the most use of. More than a hundred years ago, a brother of Gilbert White had remarked that the Swallows in passing the Straits of Gibraltar took the narrowest route, flying over the bay in a south-westerly direction, and crossing opposite to Tangier. Even after a long flight is safely accomplished, the resultant fatigue renders the poor little migrants utterly incapable of escape from the numerous enemies that lurk along the route, or follow like the most remorseless and bloodthirsty of pirates in their wake.

The greatest enemies of birds on migration are the various Hawks and Falcons and Owls that are always hovering in close proximity to the defenceless moving throng. The large Falcons follow migrating Ducks for enormous distances, preying on the helpless birds at will; the various smaller Hawks fare right royally on the Warblers, Thrushes, Finches, and such-like Passerine species. Each district

through which their fly-lines extend has its own Raptorial birds waiting to levy tribute as the migrants hurry by. Hawks have also been observed to pay long visits to islands lying on routes of migration, to prey upon the passing birds, and even to hunt for small migrants in the rays of the lanterns. Many of these birds of prey themselves are migratory, and are careful to make their own seasons of passage correspond with those of their unfortunate victims. The arrival of the Peregrine (*Falco peregrinus*), for instance, in the Arctic regions, takes place simultaneously with that of the Ducks; the Hobby (*Falco subbuteo*) does not appear until late in spring, when the woods are full of small birds; but the Merlin (*Falco æsalon*) follows the very first few venturesome migrants northwards.

We must not overlook another very fertile source of danger to migrating birds, and that is the fatal attraction of lighthouses and light-ships. The brilliant light of the various beacons that stud the coasts of the civilized world, along the direct route of countless migrants, allure birds from their direct course, especially during cloudy weather, and great numbers kill themselves as they fly dazed and bewildered against the glass. It has been universally remarked by light-keepers, that birds strike most frequently on dark cloudy nights, with fog, haze, or rain. Instances of birds striking on clear nights are exceedingly rare. Again, light-ships are more attractive to birds than lighthouses on islands

or headlands, probably because the former are the *only* visible objects on which to rest or approach, no land being near them: fixed white lights are also more deadly than the revolving or coloured lights. It is also interesting to know that fog-horns prevent birds from striking, for it has been observed that whenever one of these warning engines has been erected near a light where birds previously struck in abundance, the striking has almost ceased. Sea birds rarely strike these lights, although instances are on record where they have done so, Stormy Petrels having been known to cause light-keepers much annoyance by fluttering against the lantern and ejecting oil on the glass. Many intensely interesting scenes may be witnessed from the balcony of a lighthouse or the deck of a light-ship, favourably situated on or near a great highway of migration. Odd birds are continually coming in contact with the lights throughout the migration season; but now and then they appear in wonderful numbers, just as some great flight of birds has been suddenly deflected from its course by a fog or bank of clouds hiding the moon or stars, and throwing the surface of the earth or sea into such shadow that all knowledge of locality is temporarily lost. Here is the report of Mr. Littlewood, the keeper of the *Galloper* Light-vessel, moored fifty miles off the mouth of the Thames, made on the night of October 6th, 1882: "Larks, Starlings, Mountain Sparrows [Bramblings], Titmice, Common Wrens, Redbreasts, Chaffinches, and Plover were picked up on

the deck, and it is calculated from 500 to 600 struck the rigging and fell overboard; a large proportion of these were Larks. Thousands of birds were flying round the lantern from 11.30 P.M. to 4.45 A.M., their white breasts, as they dashed to and fro in the circle of light, having the appearance of a heavy fall of snow. This was repeated on the 8th and 12th, and on the night of the 13th, 160 were picked up on deck, including Larks, Starlings, Thrushes, and two Redbreasts; it was thought 1000 struck, and went overboard into the sea." Telegraph-wires are generally placed too low to be in the usual path of migrants, but instances are on record where birds have killed themselves by flying against them on passage. Great numbers of birds also lose their lives every year by flying unwittingly into nets spread along the coast of the Wash. The coast here is a well-recognized highway of migrants coming to our islands from the East, and birds of many species are annually taken in them. Curiously enough, the Woodcock (*Scolopax rusticola*) is rarely or never caught thus. He migrates by night like so many of the rest, but flies high until well over the land, when he drops almost perpendicularly into the most likely cover. Many Woodcocks are foolish enough, however, to commit suicide against lighthouses and vessels; and they have been known to break glass three-eighths of an inch in thickness by the force of contact—evidence, so far as it goes, of the great velocity of migration flight of some species. At the Bell Rock Lighthouse, for instance,

the keeper reports on the nights of October 31st to November 1st, 1883: "What we think were Woodcocks struck with great force. Birds continued flying within the influence of the rays of light till the first streak of day, continually striking hard all night, and falling into the sea. Although we cannot be sure, we think there was a great number of Woodcocks struck, and fell into the sea." The force with which some birds strike is terrific. A Little Grebe (*Podiceps minor*) struck the lantern of the Hasbro Light-vessel, off the Norfolk Coast, at 11 P.M. on the night of March 30th, 1883, with such force as to split the bird from the neck along the entire length of the body! The keeper of the Longstone Lighthouse reports on the night of November 10th, 1885: "One of the large Snipe struck S.E. side of lantern at 9.45 P.M., and was almost smashed to pieces." Again, as recorded in a Göttland newspaper: "A curious circumstance happened at the Färö Lighthouse on the 20th October. About 8.30 in the evening a sharp report was heard by the man on watch. He immediately went up to the lantern to ascertain the cause, when he found two of the panes of glass broken into small pieces, as well as three Long-tailed Ducks (*Harelda glacialis*) lying dead inside. There were also three lamp-glasses broken and a third pane of glass cracked in many places. On the ground below lay nine more birds of the same sort. The Ducks had come from a northerly direction. The flight must have been at a remarkable speed, as the

quarter-inch glass was smashed into many small pieces." At the Hasbro Light-vessel from Oct. 10th 1883, to January 3rd 1884, no less than 162 Sky-Larks, 73 Starlings, 23 Chaffinches, 60 Larks and Chaffinches, 1 Brambling, 3 Fieldfares, 3 Thrushes, 1 Blackbird, 1 Redwing, 2 Goldcrests, 1 Hooded Crow, 1 Rook, 1 Kingfisher, 1 Tame Pigeon, 1 Lapwing, 3 Ringed Plovers, 4 Gray Plovers, 1 Oystercatcher, 1 Curlew, 1 Whimbrel, 2 Woodcocks, and 28 Stormy Petrels, "besides a large tub and bucket-full various," struck and were killed against the lantern, or were picked up on board! At the Tuskar Rock Lighthouse, off Wexford, 1200 birds were counted as killed in a single night, whilst hundreds more fell into the sea! I might continue giving hundreds of instances of fatalities against Lights, but the limits of my space forbid.

The last most important peril of the road is the danger of losing it. Strange as the fact may seem to the uninitiated, great numbers of birds blunder every year, take the wrong direction at some important point of the journey, and find themselves eventually in countries thousands of miles to the east or west of their proper destination! It is difficult to form any estimate of the number of these little erring migrants every year, but there can be no question that it is very considerable. The young birds are the greatest blunderers, the birds that have practically no knowledge whatever of the road, and have to depend entirely on the guidance

of older birds. That this is the case is abundantly proved by the fact that nearly all the birds that accidentally wander to the British Islands from more or less remote countries are birds of the year.

The list of British birds abounds with the names of wandering species, not only from Eastern Europe and Siberia, but from Africa, and even from America.[1] These represent individuals that from some cause or another have blundered at the cross-roads, been blown far out to sea, or joined the wrong stream of migration, and journeying in its company have found themselves at last in Western Europe, in the British Islands, instead of in the Malay Archipelago, in India, in Africa, or Mexico. Without including nomadic migrants, whose movements are so erratic that there is nothing extraordinary or abnormal in their occasional visits to our islands, we have a list composed of birds essentially migratory, that may well excite our wonder when the details of each occurrence is studied. Take, for instance, the appearance of White's Thrush (*Geocichla varia*), the Siberian Ground Thrush (*Geocichla sibirica*), and the Black-throated Ouzel (*Merula atrigularis*), all birds regularly breeding in Central and Eastern Asia, and retiring to winter quarters in India, China, and the Malay Archipelago. Or even more re-

[1] It should be remarked that stray birds from the east and north generally appear in autumn, as they do also from America; but birds from Africa and from the south as a rule arrive in spring—individuals that have overshot the limits of their normal spring migration.

markable still, the occurrence of the frail and tiny Yellow-browed Willow Wren (*Phylloscopus superciliosus*), a species breeding no nearer to us than the pine forests in the valley of the Yenesay, and wintering in India and China, and which to reach us must have flown more than 3000 miles across Asia and Europe, due west, instead of 3000 miles south into India, with an experience of a sea flight (across the German Ocean), which is novel to the migration of this species! How persistently these erring individuals must have stuck to their route, every mile of it never traversed before, and only guided by the hosts of migrants following their normal course! No less remarkable are the visits of such birds as the Desert Chat (*Saxicola deserti*), and the eastern race of the Black-throated Chat (*Saxicola stapazina*), from Turkestan. Or yet again, the visit of the Needle-tailed Swift (*Chætura caudacuta*), from localities at least 3000 miles to the east, a bird whose regular winter quarters are at the Antipodes! Then we have the visits of the Nearctic Yellow-billed Cuckoo (*Coccyzus americanus*), representing a direct flight of 4000 miles or more, with a possible rest at the Bermudas and the Azores by the way! Or the by no means less wonderful appearance of the American Bittern (*Botaurus lentiginosus*), a bird that was actually first made known to science from an example shot in Dorset ninety years ago!

Common British species are just as likely to blunder on the way as others. The Common

Snipe (*Scolopax gallinago*) has wandered to the Bermudas; the Common Heron (*Ardea cinerea*) has visited Greenland more than once; the Corn Crake (*Crex pratensis*) has strayed as far as the Atlantic States of America, and even to New Zealand! Again, the Redwing (*Turdus iliacus*) has been known to visit Greenland, the Woodcock (*Scolopax rusticola*) New Jersey and Virginia! Lost birds from one region are continually turning up in other regions throughout the world; it is the rule rather than the exception. As the avifauna of each country becomes more closely studied, these instances of lost birds will undoubtedly be found to be more numerous than is at present suspected. Of the thousands of birds that annually lose their way on migration, but very few are ever captured or recorded. It is only when these wandering individuals enter a district bristling with enthusiastic ornithologists and sportsmen that they are liable to be captured; and even then not one in ten is probably observed.

Whilst on the subject of lost birds our attention naturally turns towards Heligoland, the place of all others where watch has been most strictly kept for their appearance. The publication last year of Gätke's long-expected and long-delayed volume, *Die Vogelwarte Helgoland*, enables us to form some idea of the number of birds that lose themselves on passage; but after all, the list of birds occurring on the much-vaunted island is, to say the least, disappointing. Perhaps we expected too

much. Again, it is most exasperating to find records based on evidence of the most flimsy kind, and the occurrence of such a species as *Turdus pallens*, for instance, resting on the identification of a bird-stuffer, who only saw and did not obtain the bird! Or, worse still, *Phylloscopus fuscatus* is admitted to be a bird of Heligoland, because an example was supposed to have been seen! The evidence is only too apparent that every means has been used to swell this list to its greatest possible length, just as certain British naturalists seek to increase the British list on worthless testimony, a method that may suit the collector and the dealer, but ill becomes the man of science. I can safely say I have never met with a list, claiming to be authoritative, in which so many species have been inserted on the most trumpery evidence, during the entire course of my experience. It is an insult to ornithological common sense, and in many ways gives the much-maligned *Ibis List of British Birds* a long start and a good beating! Bad as this Heligoland list undoubtedly is, it contains, however, certain items of profound interest, illustrating the world-wide wanderings of birds. Some of the most wonderful abnormal bird-flights are those taken by migratory Nearctic Thrushes, such as the visit of *Turdus swainsoni* and *Turdus migratorius* in October 1869 and 1874 respectively. No wonder the latter example was found dead after an ocean flight of so many thousands of miles! None the less remarkable are the occurrences of *Mimus*

carolinensis, *Dendrœca virens*, and *Dolichonyx oryzivora*, the latter the wide-ranging Rice Bird, which, as we have already seen, wanders to the Bermudas and the Galapagos. It is also very interesting to remark how so many species of Phylloscopi (of which our Willow Wren, *Phylloscopus trochilus*, is a typical species) lose their way on migration, and travel West from Central Asia, instead of South to India and elsewhere. Individuals of the various species of East Palæarctic Buntings (*Emberiza*) blunder almost equally as much.

All this is very interesting, but we expected much more from the way Heligoland has been lauded for the past twenty years. Now what are the real facts of the case? The list of birds obtained on Heligoland includes no more than forty species that have not hitherto been observed in the British Islands, although there can be no doubt whatever that many of them have visited us. As a set-off against this, however, the list of British birds contains no less than fifty wanderers (not nomadic migrants) that have not yet been noticed on Heligoland; and we may reasonably conclude that they have not visited the island under any ordinary circumstances, or they would either have been captured or at least identified by such sharp eyes as can determine *Phylloscopus fuscatus* from every other Willow Wren (at least twenty-five species), even when alive and at liberty!

The following table will serve to demonstrate these facts :—

British Species not observed hitherto on Heligoland.	Heligoland Species not observed hitherto in British Islands.
1. Vultur fulvus	1. Circus pallidus
2. ,, percnopterus	2. Lanius meridionalis
3. Elanoides furcatus	3. ,, isabellinus
4. Astur atricapillus	4. Muscicapa albicollis
5. Surnia hudsonia	5. Turdus swainsoni
6. Saxicola isabellina	6. ,, fuscatus
7. Geocichla sibirica	7. ,, ruficollis
8. Regulus calendula	8. ,, migratorius
9. Tichodroma muraria	9. Mimus carolinensis
10. Loxia leucoptera	10. Erithacus philomela
11. Zonotrichia albicollis	11. Ruticilla mesoleuca
12. Fringilla canaria	12. Phylloscopus bonellii
13. Agelæus phœniceus	13. ,, tristis
14. Scolecophagus ferrugineus	14. ,, proregulus
15. Sturnella magna	15. ,, coronatus
16. Chelidon bicolor	16. ,, borealis
17. Progne purpurea	17. ,, viridanus
18. Chætura caudacuta	18. ,, nitidus
19. Caprimulgus ruficollis	19. Hypolais polyglotta
20. Ceryle alcyon	20. ,, elaica
21. Cuculus glandarius	21. ,, caligata
22. Coccyzus americanus	22. Acrocephalus agricola
23. Coccyzus erythrophthalmus	23. Locustella certhiola
24. Coracias indicus	24. ,, fluviatilis
25. Turtur orientalis	25. Dendrœca virens
26. Ectopistes migratorius	26. Saxicola morio
27. Botaurus lentiginosus	27. Motacilla citreola
28. Butorides virescens	28. ,, melanocephala
29. Ægialitis vocifera	29. ,, viridis
30. Vanellus gregarius	30. Alauda pispoletta
31. Totanus solitarius	31. ,, tartarica
32. ,, flavipes	32. Emberiza aureola
33. Ereunetes griseus	33. ,, cæsia
34. Tringa bonaparti	34. ,, cia
35. ,, minutilla	35. ,, pityornis
36. Sterna leucoptera	36. ,, pyrrhuloides
37. ,, hybrida	37. Dolichonyx oryzivora
38. ,, fuliginosa	38. Carpodacus roseus
39. Larus melanocephalus	39. Hirundo rufula[1]
40. Colymbus adamsi	40. Larus affinis
41. Puffinus obscurus	
42. Oceanites wilsoni	
43. Œstrelata torquata	
44. ,, hæsitata	
45. Bulweria columbina	
46. Daption capensis	
47. Bernicla glaucogaster	
48. ,, ruficollis	
49. Cygnus buccinator	
50. ,, americanus	

[1] Recorded also as British.

NOTE.—Possibly Emberiza cioides castaneiceps should be included among the British species.

There is little then to mark Heligoland from the rest of Europe, so far as its list of rare migrants is concerned—all that we can say is, that it has been a little better worked and much more closely watched. The lost birds that wander to the British Islands from time to time are not one iota less interesting, or their occurrence less wonderful, either in the distance they have travelled or the route they have followed. That Heligoland is situated on or near one of the most important migration routes in the Eastern Hemisphere cannot be questioned; but there is nothing abnormal about migration there; and in some species the Flight is much more apparent in our islands. The most remarkable feature is, that migration becomes more contracted there than on the British or Continental coast-line, probably owing to Heligoland being so isolated, some twenty miles from land, offering not only an easily recognized land-mark, but a resting-place for lost and weary strangers from afar.

In one way Heligoland has the advantage of the British Islands. It is more favourably situated for tapping that great East to West migration wave (notorious for the comparative abundance of small Passerine species abnormally carried with it) that sets in from the far East in autumn and gradually spends itself down the Baltic and the valleys of the Danube, the Elbe, and the Rhine. Consequently many of the lost and wandering birds in the wrong stream of migration, are caught before they can reach our islands, or are more apt to

be overlooked in a country so large as Britain. Moreover nearly all these Heligoland rarities are small Passerines, and of dull colours, or closely resemble commoner species whose presence excites no interest. Some, however, do escape, probably by way of the Rhine, and reach our shores, among the most remarkable being the Needle-tailed Swift. We are also richer than Heligoland in lost wanderers from the south and from America, owing to the British Islands being the first land to be sighted on this side of the Atlantic, at least *half* the species in the above table being from that Continent. Such facts are only too obvious, and make the wonders of Heligoland, great as they are, appear far more legendary than real. It may be worthy of remark to call attention to the curious fact of so many rare and abnormal migrants occurring in certain districts. Many of our rarest visitants have been taken one after the other, both individuals as well as species, along certain lines or in certain spots, which seems to indicate that there is at least some method in their movements.

I trust I have now succeeded in my endeavour to show at least a few of the principal perils that surround the migrant birds. Mortality is high amongst them; and yet this heavy death-roll serves a wise and important purpose, as a Check upon the undue increase of birds so specially favoured as they who live almost in a perpetual summer, or under conditions that entail the very lowest minimum of privation.

CHAPTER IX.

THE DESTINATIONS OF THE MIGRANTS.

The Great Summer Quarters of Migratory Birds—Limits of Palæarctic and Nearctic Regions—Their Comparative Avifaunas—Reasons for Poorness of Nearctic Avifauna—Winter Quarters of Palæarctic Migrants—Winter Zones of West Palæarctic Birds—Winter Zones of East Palæarctic Birds—Comparison of Winter Range of East and West Palæarctic Species—Influence of Gulf Stream on Geographical Distribution and Migration of Birds—Climate of Nearctic Region—Effects on Migration—Winter Zones of Nearctic Migrants—Bird Life in the Southern Zones during Winter—Winter Quarters of Southern Hemisphere Migrants—Northern Sea Flights—Isothermal Lines of Temperature—Temperature and Breeding-Grounds—Effects of Varying Temperature on Birds—Our Knowledge of the Geographical Distribution of Birds yet rudimentary.

EVERY regular migrant has a definite Winter Home. At one end of its fly-line the usual breeding-grounds are situated; at the other end the locality where it spends the winter, or, as in the case of a very great number of instances, the place where it enjoys all the luxury of a second summer. To make no allusion to these northern and southern destinations in a work devoted exclusively to the Migration of Birds would be an unpardonable omission.

Broadly speaking, in the Northern Hemisphere, a bird's winter quarters are more or less directly south of its breeding-grounds; whilst in the Southern Hemisphere they are situated to the north of them. Of course there are exceptions to this, as we shall learn in the two following chapters, when we come to deal with the two great seasonal movements; whilst the distance between the winter and summer limits vary to a great extent, according to the length of migration flight and its general direction. The two great summer quarters of migratory birds are situated in the Palæarctic and Nearctic regions. The former region embraces Europe (including Iceland), Africa north of the Great Desert, Asia Minor, Northern Persia, and the remainder of Asia north of India, and the Yangtse valley to Japan and the Aleutian Islands. The latter region comprises Greenland and the entire continent of North America to about north latitude 20° in Southern Mexico. The latter region is by far the poorest in what we may designate Temperate species, probably in the ratio of about two to one. This is owing to the very obvious reason that when birds were banished from the circumpolar zone, glaciation was not only far more severe in the Western than in the Eastern Hemisphere, but the land surface, and consequent accommodation for bird life, directly south of the eastern half of that circumpolar zone, was more than double the area of that directly south of the western

half of that zone. As a natural consequence, double the number of species retreated south into Europe and Asia, than penetrated into North America; or if the numbers were about equal, competition between species being keener, owing to more restricted area, and climate being so much more unfavourable to avian life, a much higher rate of mortality resulted in a present avifauna of such comparative poorness. Amongst its most important gaps may be mentioned the entire absence of the thoroughly Palæarctic Sylvinæ. In every part of these two mighty areas, from the highest Polar land yet visited by man, down to Mexico, Algeria, Northern Persia, the Yangtse, and Japan, migratory birds come from the south in spring to breed, and return to the south in autumn to winter. The migration flight of course varies to a very great extent, reaching for 10,000 miles or more in the most northern species, and dwindling down to perhaps a couple of thousand, or even one thousand, amongst the most extreme southern species. It now becomes necessary, owing to different climatal conditions, to speak of each of these great regions separately.

The great winter quarters of Palæarctic migrants are in Africa, India, South China, the Siamese Peninsula, the Malay Archipelago, Australia, and New Zealand. Birds visiting the West Palæarctic region, at least as far east as the Urals and the Obb valley, normally winter in Africa and Turkey in Asia, but a few retire to India, and a few to

China and Malaysia, birds that have obviously increased their summer area westwards within comparatively recent time. Birds visiting the East Palæarctic region, from the Urals or the Obb valley to Kamtschatka and the Aleutians, normally winter in Arabia, Persia, and India, eastwards to China, and southwards to Australia and New Zealand; but a few in a precisely similar way retire to Asia Minor and Africa, birds that have extended their summer area eastwards within equally recent time. The winter quarters of West Palæarctic migrants may be divided into three well-marked regions or zones. The first of these zones is the Great Aquatic Zone, consisting of the North Sea, the Baltic, the West Atlantic down to Madeira, the Mediterranean, the Black and the Caspian Seas, the Red Sea, and part of the valley of the Nile. The second of these zones may be said to include the extreme southern portions of Europe, Turkey in Asia, Persia, the Arabian Peninsula, and all Africa north of the Equator. The third of these zones consists of Africa south of the Equator, including Madagascar. The first or aquatic zone is the great winter quarters of West Palæarctic migratory water birds, especially Swans, Geese, and Ducks (ANATIDÆ), Grebes (PODICIPEDIDÆ), and various Waders (CHARADRIIDÆ). As might naturally be expected, the land birds wintering in the extreme northern portions of the second zone, between South Europe say and the Atlas, are few. Among

them may be mentioned the Ring Ouzel (*Merula torquata*) and the Kestrel (*Falco tinnunculus*); but those that winter from South Europe to the Soudan and the Equator number a great many species, such as the Whinchat (*Pratincola rubetra*), the Grasshopper Warbler (*Locustella locustella*), the Willow Wren (*Phylloscopus trochilus*), and the Tree Pipit (*Anthus arboreus*); whilst those that winter exclusively south of Europe are even more considerable. Among them may be included the Redstart (*Ruticilla phœnicurus*), the Pied Flycatcher (*Muscicapa atricapilla*), and the Marsh Warbler (*Acrocephalus palustris*). The birds journeying exclusively to the southern zone are comparatively few, and include such species as the Swallow (*Hirundo rustica*), the Red-backed Shrike (*Lanius collurio*), and the Cuckoo (*Cuculus canorus*). The birds whose winter range extends through all these zones are few, among them being the Quail (*Coturnix communis*), the Common Sandpiper (*Totanus hypoleucus*), the Kentish Plover (*Ægialophilus cantianus*), and the Land Rail (*Crex pratensis*). Some of these birds even winter as far north as the British Islands, and as far south as the Cape of Good Hope! Whether this apparently anomalous fact has any connection with the Neutral Zone of migrants alluded to in a previous chapter remains to be discovered.

In the East Palæarctic region much the same state of things will be found; but owing to the influence of the Gulf Stream, the winter zone of aquatic birds extends much further north in the

West than in the East. Thus, for instance, while we find many Ducks and Geese wintering off the coasts of Scandinavia, and even in the Baltic on the Atlantic sea-board of Europe, but few, if any, frequent Lake Baikal, the seas round Kamtschatka or the Sea of Ochotsk, situated in precisely similar latitudes in Central Asia and on the Pacific sea-board of that continent. The aquatic zone of East Palæarctic birds may be said to be the lakes and great rivers of India and China, the northern portions of the Indian Ocean, and the China, Yellow, and Japan Seas. For the same great climatal reasons—the East Palæarctic region being so much colder than the West—the winter zones of land birds not only do not commence so far north, but extend many degrees further south than South Africa, into Australia and New Zealand. The northern winter zone may be said to include Turkestan, Afghanistan, India, Burma, the Siamese Peninsula, South China, and the south island of Japan. A comparison of the winter range of some extreme eastern Palæarctic species with that of others in the extreme west, affords interesting evidence of the great influence exerted by the Gulf Stream on the migration of birds. Take, for example, the Redwing (*Turdus iliacus*), breeding in Scandinavia, say in lat. 65°, and wintering in the British Islands only ten degrees further south, and compare it with the Dusky Ouzel (*Merula fuscata*), breeding in a similar latitude in Eastern Siberia (lat. 65°), but wintering in China and Japan, more than 1000 miles further

south than the Redwing has to travel to find suitable winter quarters. The absence of Gulf Stream influence lowers the breeding-range of great numbers of species in the far east, just as in the far west its presence extends them. Numbers of instances might be given of Palæarctic birds reaching their highest or lowest breeding-range in Scandinavia, where that warm ocean current increases the temperature to a very remarkable degree. The Brambling (*Fringilla montifringilla*) breeds only as low as lat. 60° in Scandinavia, but can find temperature suitable for this function at least ten degrees lower in Eastern Siberia. In the west, owing to Gulf Stream influence, it is able to winter throughout the British Islands, and even in South Sweden; but in the far east it is compelled to journey into China and Japan, and thus increase its fly-line by at least 1000 miles! The Sand Martin (*Cotyle riparia*) is a circumpolar bird, and breeds nearly up to the North Cape (about lat. 70°) in Scandinavia, but in Kamtschatka not any higher than lat. 55°; and in the Nearctic region not beyond lat. 68°. In this northern winter zone by far the greater number of East Palæarctic land birds visit India and South China, the land lying immediately north of the Equator being by far the most patronized, just as we find to be the case with West Palæarctic birds. The southern winter zone of East Palæarctic land birds includes the Malay Archipelago, Australia, and New Zealand, and curiously enough is visited in the extreme south by comparatively few yet very similar species as in the west.

We now proceed to discuss the Nearctic region. Owing to prevalence of a much more severe climate throughout the northern portion of this vast land area, the comparative percentage of migratory birds is considerably higher than in the Palæarctic region. Although the land surface of the Nearctic region is, broadly speaking, only about half that of the Palæarctic region, the surface exposed to an Arctic climate (say with a midsummer mean temperature of 60° or less) is certainly more than double the surface exposed to a similar temperature in the Palæarctic region. This important fact is reflected in the migrations of Nearctic birds. The great majority of species breeding north of the United States, or in about the same latitude as the south of France and the valley of the Danube, are migratory; only the most boreal species remain to brave the rigours of a British North American winter. On the other hand, the summers are hot, and the entire region supplies breeding-grounds to a very large number of species.

The first or winter zone of aquatic migratory birds in the Nearctic region may be said to include the Great Lakes and rivers of the United States, and the St. Lawrence, down to the Gulf of Mexico in the Atlantic, and the Californian Gulf in the Pacific. The second or winter zone of land birds may be said to include all but the most northerly of the United States, Mexico, Central America, the West Indies, and the northern portions of South America, say to the Equator or the valley of the Amazon.

The third winter zone consists of the remaining portion of South America. It will be remembered that here, as in the East Palæarctic region, the winter zone extends many more degrees south than in the West Palæarctic region, due mainly to the severe or mild winter climate in the north of each area respectively. By far the greatest number of terrestrial species winter in the second of these zones, as we should naturally expect to be the case, seeing that the *Temperate* area of the Nearctic region is so remarkably contracted. Many species, however, especially among wading birds, penetrate far below the Equator, and some few extend their fly-line to Patagonia. Unfortunately, the meagreness of our knowledge of Neotropical ornithology is a serious obstacle to the exact definition of this great Southern Zone of Winter Migrants from the Nearctic region.

All these southern zones are eminently suitable for the winter residence of migratory birds. In every zone the various species wintering therein find food in abundance. Nowhere does any of these zones encroach upon a region of perpetual winter snow and frost, whilst the more tropical of them enjoy a climate beautiful in the extreme. The habits of the Migrants have been little studied in these winter quarters; but no bird breeds a second time within them during absence from its northern home. Many singing birds appear to regain their song, just as the Robin and the Starling do in our islands during winter; but Love and all that pertains thereto seems to remain utterly in abey-

ance. The winter is passed in a state of rest after the mercurial energy of the previous summer, and the fatigue of the long Migration Flight. During winter in these southern regions the land is a land flowing with milk and honey for migratory birds; insects swarm, the strands and mud-flats teem with living things; the air, the water, and the vegetation alike abound with food; whilst in more temperate regions the ground is free from frost, and furnishes birds that seek their food therein a seldom failing store, and the berries and seeds on which many birds almost exclusively fare are never hidden by the snow for long together. The great attraction in these winter haunts is this superabundance of food; whether it is sought in South America, in Mexico, or the West Indies; in sultry Africa, or India; in China, in Japan, in Malaysia, or far-away Australia—it has been and is one of the strongest incentives to the Migrants' southern flight during the long-past ages that Avian Season Flight has been the dominating necessity of its life! But with the return of the northern summer, as the sun steadily progresses towards Cancer, a great change comes over the scene. Hot desolation fills many of these southern lands; rivers and streams dry up; vegetation is scorched, and conditions of life for the love-sick migrant hosts become as unbearable as they became in the northern world in autumn, and the great northern exodus begins.

So far the destinations of migrant birds have been exclusively confined to those of species that

retreat from a northern winter and advance more or less closely towards regions enjoying a southern summer or a perpetual warm climate. It remains for us now to glance briefly at that other class of birds, not certainly so numerous, yet just as important, that is retreating from a southern winter and seeking a destination more or less closely towards a region where northern summer is prevailing, or climatal conditions are less rigorous. We have already had occasion to remark upon the comparatively small number of Southern Hemisphere Migrants, and to trace the cause; still the movement north is not only a marked but an excessively interesting one, and the Destinations of these northern winter migrants therefore demands notice. A migration from south to north only takes place upon the three great southern land masses of South America, Africa, and Australia, and from various small islands in the Southern Seas. With the sole exception of a few birds breeding on what we may call the outskirts of the glaciated Antarctic continent, this migration, for reasons we have already dwelt upon, does not extend far, if at all, beyond the Equator.

By far the most interesting example of this northern winter flight is that taking place in the Australian region, for there we have, so far as land birds are concerned, the only known important instances of birds absolutely crossing the sea to reach northern winter quarters situated in New Guinea and other islands of the Malay Archipelago.

In South Africa the northern zone of winter migration extends through the Transvaal and Damara Land to the Congo and the great system of equatorial lakes at the source of the Nile. In South America the northern destination of the Neotropical migrants reaches through La Plata to Peru and Brazil; and here, but on a much smaller scale, we have a sea flight north from the Falklands and Tierra del Fuego. Precisely the same causes influence migration in the Southern Hemisphere as in the Northern Hemisphere, scarcity of food owing to a prevailing lower temperature; although nowhere is this as acute as in the Northern Hemisphere.

With the return of spring in either Hemisphere the great wave of bird-life once more begins to flow north or south, according to circumstances, to the breeding-grounds in more temperate climes—a vast tide of Migrants that permeates every district and only spends itself in regions as far north or south as land is known! The great variation in climate over so vast an area of course determines the migration limits of individual species, due regard being paid to the isothermal lines of temperature. I am of opinion that much light will yet be thrown on the Phenomenon of Migration generally when this important condition is more closely studied. That Temperature has a great effect on a choice of breeding-grounds is unquestionable; that Temperature varies greatly over wide areas in obedience to ocean currents and other influences irrespective of

latitude or longitude is equally certain. I only allude to this subject again in the hope of directing research thereto; it involves a much greater amount of labour than I have yet unfortunately been able to devote to it; and would, to be dealt with at all adequately, make far too wide a demand on the space here available for its discussion. After all, this little volume is but a pioneer in an almost unknown land, and no one is more conscious than its author of the utter impossibility of exhausting in a first attempt so wide and so little worked a subject as the Migration of Birds, even though that first attempt embodies the research and observation of a life-time. Its aim and purpose is but to point the way to more elaborate and detailed investigation, and to seek to rescue from chaos a branch of Ornithological science as fascinating and as absorbing as any alchemist's endeavour to accomplish the transmutation of gold!

That variation in Temperature was one of the most powerful initiating causes of Migration we have already seen; it is only natural to presume that it still continues to exert incalculable influence on Migration; otherwise we should not witness all these intricate and complex phenomena that so large a part of this volume has been written in the earnest endeavour to describe and possibly to explain. Depend upon it, the ebbing and the flowing of this great tide of Avian Life is not governed by chance; the habit of Passage is too vitally important, too deeply rooted, too grandly ancient, to have a trivial

cause, either to be lightly acquired or to be readily relinquished.[1] The present chapter, then, meagre as it is, will, I hope, serve to show that the Destinations of the Migrants are of some importance in a study of Avian Season Flight, and assist in no small degree to its ultimate elucidation. Our knowledge of the geographical distribution of birds is still far from being even approximately complete. Too little attention is paid to the habits of birds, or to the fact of birds being migratory or not, and, if the former, the dates of their arrival and departure, and the various causes that initiate these periodical movements. Alas! only too often has an interesting and pregnant thread of investigation been suddenly snapped by the failure to obtain such requisite information; and until we are in possession of this data I can confidently assert that much will remain unsolved and inexplicable in the Migration of Birds.

[1] The notoriously early age at which the Impulse to migrate is manifested, seems to me one very convincing proof of the vast antiquity of the habit of Migration. Young birds, as we have already seen, are almost universally the first to display a restless desire for Flight in autumn, and to leave their birthplace before the bulk of the older individuals.

CHAPTER X.

THE SPRING MIGRATION OF BIRDS.

The Dominating Impulse of Spring Migration — General Aspects of Spring Migration—The Greatest Travellers generally the Latest Starters—Avian Waves of Spring Migrants—Spring Routes sometimes different from Autumn Routes — Intensity of Migration — Spring Migration of Turtle Dove and Common Sandpiper—Day and Night Migration reversed according to Season—Minor Streams of Spring Migrants—Abnormal Direction of Fly-lines—Migration of Rose-coloured Pastor, Scarlet Rose Finch, and Black-headed Bunting—Spring Migration gradual in Southern Zones — Sudden Spring Migration in Arctic Regions—Arrival of Birds in Northern Europe—Arrival of Birds in Siberia—Rush of Birds across the Arctic Circle—Migration of Geese—Arrival of Waders—Various Routes to the Tundra from the South—Spring Migration in High Arctic Latitudes—In Grinnell Land—In Arctic America—Table of Spring Migrants—Return of Birds to Old Haunts—Migration and Reproduction.

The Great Spring Migration of Birds may be said to commence when the sun has performed about a third of his journey towards the Tropic of Cancer, or, in other words, about the middle of February. Migration flows and ebbs with the sun. The spring migration advances in the wake of the sun, on his apparent northward course, and in the same way retreats to follow that great central luminary to

the Southern Hemisphere. Unquestionably the one grand dominating impulse of Migration in spring is Reproduction. Migratory birds come north to breed, to rear their young in a climate where the temperature is best suited to their several requirements. That this is so seems proved by the fact that the adult birds are the first to migrate northwards in spring, birds whose sexual instincts are mature and strong; the young of the previous year in a great many cases do not extend their spring flights quite to the usual breeding-grounds of their species, and in other cases actually remain close to their winter quarters right through the summer. Another very remarkable fact about Spring Migration is the much greater rapidity with which it is performed. Birds may not fly any faster in spring, but they do not linger so long on the road; they seem bent on getting to their summer quarters as quickly as possible when once they have fairly started. It seems a wonderful and very remarkable fact how the earliest spring migrants time the date of their arrival to such a nicety that they are back in their old haunts almost to the moment that winter finally departs. But this fact is really not so very amazing after all. Birds as they near their northern destinations have often to wait about for spring, having been too eager to press onwards, and then great numbers collect on the very outskirts of retreating winter, ready to renew their flight at the first suitable opportunity. This is not so readily remarked in

such temperate latitudes as the British Islands (although instances are on record where the earliest flights of Migrants have been delayed for days together in countries immediately to the south of them), where the transition from winter to spring is very gradual. In the Arctic regions, however, season change is much more rapid, winter merging into spring after a south wind of twenty-four hours' duration; and then the interesting sight can be repeatedly witnessed of birds arriving a day or so too soon with the first signs of a thaw, and having to retire south again for a few miles to the nearest open water, or land free from snow. It is also interesting to remark that many of the birds that have the furthest to go are the last to start from their winter quarters, and this appears to apply equally to individuals as well as to species. Thus the Swallows (*Hirundo rustica*) that breed in South Europe begin to leave South Africa about the middle of February, but those that breed in North Russia delay their departure until the middle of April, just as if they were perfectly well aware that their summer quarters in the Arctic regions would not be ready for them for several months longer! This great wave of spring migration lasts practically for about four months; beginning to set in towards the north from the Antipodes about the middle of February, and continuing until nearly the middle of June, spending itself gradually at the latter date in the highest Polar regions visited by birds. Gradually this great migration wave may be traced

spreading northwards, from Africa, India, or China, for instance, right across Europe and Asia to the Arctic regions. All the various important Routes of Migration are more or less thronged with journeying birds; and at the intermediate stations famous for Flight, species after species appears at its usual time and passes on. At Gibraltar, along the chain of the Atlas mountains, at Malta, in the Greek Archipelago, in the Nile Valley, along the Red Sea, and at the great passes of the Himalayas, as well as up the Chinese river valleys and coast-lines, Birds in countless hosts are quietly pressing on—all with one common purpose in view, that of reaching their nesting-places as quickly as possible and settling down to family duties. As each species, or the individuals of each species, reach their haunts, the Great Avian Wave gradually decreases; the further and further north it flows the number of species become less, until all but the most Arctic ones remain.

Some species for reasons at present quite inexplicable follow a different route in spring from that which they traverse in autumn. This is proved by the following facts. The Nightingale (*Erithacus luscinia*) passes over Heligoland in April and May, but has never been caught there in autumn; the Dotterel (*Eudromias morinellus*) is rarely or never seen in Malta in spring, but passes that island regularly enough in autumn; the Turtle Dove (*Turtur auritus*) passes Heligoland commonly in May and June, but is much less

abundant in autumn. The Whimbrel (*Numenius phæopus*) is another instance. In spring it passes the British Islands on passage much more abundantly than in autumn, and it has been remarked to fly much higher at the latter season. The intensity of the migration of each species varies considerably. First a few stragglers appear, and then the individuals gradually become more and more numerous until the migration is at its height; then it slowly dies down again, and a few laggards bring up the rear and conclude the Passage of each particular species for the season. At Gibraltar, for instance, the Turtle Dove begins to pass north on passage about the middle of April, and the flights gradually increase in volume until the first week in May, during which period the migration of this species is at its height, and then the numbers again decrease, until by the middle of the month the spring passage is practically over. At the same locality the Common Sandpiper (*Totanus hypoleucus*) begins to arrive early in March, and continues to increase in numbers until the middle of April, when it literally swarms there, after which the passage gradually gets less and less, until early in May, when it has ceased for the season. At Heligoland, at Malta, in Greece, in Asia Minor, at every station where migration has been carefully watched, precisely the same conditions prevail, and almost every species is alike in this respect. It is also a curious and interesting fact that some species migrate by night in spring,

yet travel by day in autumn, as for instance the Quail (*Coturnix communis*); whilst others journey by day in spring and by night in autumn, as for instance the Common Bee-eater (*Merops apiaster*); others yet again always by day or by night, or by day and night at both seasons. The reason for this change according to season remains a mystery, and the practice may be found to prevail more extensively when Migration becomes better known.

The general direction of Spring Migration, as previously remarked, is broadly speaking from south to north, yet there is a considerable amount in other directions. Some of these what we may call minor streams of migration are intensely interesting, not only in themselves, but as showing how certain species have increased their areas of distribution in summer in a longitudinal rather than in a latitudinal direction. Hence we not only find migration from east to west in spring, but from south-east to north-west, as well as the almost universal stream from south to north. The Rose-coloured Pastor (*Pastor roseus*) winters in India, and migrates to South Siberia, Turkestan, the Caucasus, South Russia, and as far west as Italy, to breed. Canon Tristram observed incredible numbers of this species on migration in spring, crossing the plains of Syria in the Orontes Valley. For three days during the last week in May flocks continued to pass one after the other all flying due west towards Europe. The birds made considerable noise as they flew along, chattering to each

other; and the sound of myriads of voices was deafening as the clouds of birds passed on, or wheeled and gyrated in the air like Starlings. A vast flight of locusts had attracted the migrating Pastors, and the birds formed "a great globe in the air which suddenly turned, expanded, and like a vast fan descended to the ground," which in a few moments was covered with a moving black and pink dappled mass of birds! On other occasions trees were observed literally black with them; and again, on being disturbed from a pool of water where they had alighted to drink, the air was darkened with their numbers as they rose and hurried out of harm's way. It is said that these vast flights of Pastors are only seen in Palestine during spring migration, when their flight is from east to west. The Scarlet Rose Finch (*Carpodacus erythrinus*) winters in India and Burma, yet extends its spring migrations as far to the west as the Baltic Provinces, and as far to the east as Kamtschatka. Its fly-lines, therefore, go exactly north-east and north-west from a common winter centre! The Black-headed Bunting (*Emberiza melanocephala*) also winters exclusively in India, and in spring migrates nearly due west across Afghanistan and Scinde, to breed in Persia, Palestine, the Caucasus, Asia Minor, Greece, Turkey, and Italy. All these birds are remarkably late migrants, not arriving at their European breeding-grounds before May. They all appear to have a dislike to cross the sea on migration, and this explains their exceeding rarity

in the British Islands. They appear to follow the narrow strip of land, including Persia and Turkey in Asia, which is bounded by the Mediterranean Sea and the Persian Gulf on the south, and by the Caspian and Black Seas on the north; and their fly-lines must actually cross at right angles those of species passing from Africa to Northern Europe by way of the Black and Caspian Seas and Volga and Ural valleys. Then again we have migrants from the extreme south-east of Asia, *en route* to the far north-west of Europe. The Rustic Bunting (*Emberiza rustica*) winters in China, and extends its spring migrations as far west as Finland. The fly-line of individuals breeding in Europe apparently crosses Mongolia and follows the valley of the Yenesay and the Obb, thence across the Urals into those of the Petchora and the Dwina. The Little Buntings (*Emberiza pusilla*) that breed in North Russia, probably winter in India. The north-westerly fly-lines of these two birds are crossed by the north-easterly fly-lines of such birds as the Sedge Warbler (*Acrocephalus phragmitis*) and the Willow Wren (*Phylloscopus trochilus*), many individuals of both these species leaving winter quarters in Africa or Persia, and migrating at least as far to the north-east as the valley of the Yenesay, and higher than the Arctic Circle. The Roller (*Coracias garrula*) breeds in Cashmere and winters in Arabia and Africa, not visiting India at that season!

South of the Arctic Circle the arrival of spring

birds is gradual, weeks and even months separating the date of appearance of certain species. This seems entirely due to the fact that spring in temperate regions lasts for about a couple of months; but in the Arctic regions, where winter passes into summer with scarcely a day's spring between them, the arrival of migratory birds is sudden and much more simultaneous. Migration in these high latitudes depends almost absolutely upon the break-up of the ice, which may be a few days earlier or later according to local influences. Two of the most complete and graphic records of the spring migration of birds in the Arctic regions are those made by Mr. Seebohm; the first in the valley of the Petchora (in company with Mr. J. A. Harvie-Brown) during the spring of 1875; and the second in the valley of the Yenesay during the spring of 1877. Both Migrations are very much alike in their general aspects and conditions. In each case little migration was observed until the ice on the rivers began to show signs of dissolution. Such Nomadic Migrants as Bullfinches, Snow Buntings, and Redpoles were the first to make their appearance, birds that had wintered close to the fringe of perpetual winter snow. Soon after these birds arrived, the Hen Harrier (*Circus cyaneus*) and the Merlin (*Falco æsalon*) appeared upon the scene, evidently having followed their prey from the south; and as soon as these little Finches moved further north or into the forests their enemies followed them. About a week later (May 10th in the

Petchora valley), and as soon as the snow had melted here and there from the river banks, and the first streams of open water were visible, the Shore Lark (*Otocoris alpestris*) and the Bean Goose (*Anser segetum*) arrived, followed the next day by the Hooper Swan (*Cygnus musicus*), Bewick's Swan (*Cygnus bewicki*), and the Siberian Herring Gull (*Larus affinis*). The day following, May 12th, rain fell, and the first regular migrant Passeres, the White Wagtail (*Motacilla alba*), the Meadow Pipit (*Anthus pratensis*), and the Redstart (*Ruticilla phœnicurus*) "entered an appearance." On the 13th of May, Ducks of various species arrived, and in their wake the Peregrine Falcon (*Falco peregrinus*). On the 14th, the Reed Bunting (*Emberiza schœniclus*) was identified; and the day following a large flock of Common Gulls (*Larus canus*) appeared on the rapidly-breaking-up river. The week of the Arctic spring, during which the thaw of the day was more or less refrozen at night, was now over, and on the 16th of May summer set in with startling suddenness. The flooded river choked with melting snow overflowed its banks; the ice broke up with a great crash, and migration progressed more merrily than ever. On the 17th of May flocks of Fieldfares (*Turdus pilaris*), Redwings (*Turdus iliacus*), and Golden Plover (*Charadrius pluvialis*) were observed, and Geese, Swans, and Ducks in increasing numbers migrated down the river towards their more northern breeding-grounds. The migration of the

Meadow Pipit was still in progress, and the Red-throated Pipit (*Anthus cervinus*) was remarked for the first time. The Snow Buntings and Redpoles had now disappeared from the streets of Ust Zylma; flocks of White Wagtails had taken their place, and amongst them the Gray-headed Wagtail (*Motacilla viridis*) was observed. The next day brought the Lapland Bunting (*Emberiza lapponica*), the Whimbrel (*Numenius phæopus*), and the Teal (*Anas crecca*); and the last of the Snow Buntings passed on to the north. The Willow Wren (*Phylloscopus trochilus*) arrived on the 20th of May, and the next day a Crane (*Grus cinerea*) passed over, flying north at a great height. On the 22nd of May, the Siberian Chiff-chaff (*Phylloscopus tristis*), a distinguished stranger all the way from India, arrived; and with it came the Skylark (*Alauda arvensis*), the Tree Pipit (*Anthus arboreus*), and the Stonechat (*Pratincola rubicola*). On the 24th of May, the Brambling (*Fringilla montifringilla*) arrived. Two days later Oyster-catchers (*Hæmatopus ostralegus*), Ringed Plovers (*Ægialitis hiaticula*), Wood Sandpipers (*Totanus glareola*), and Temminck's Stint (*Tringa temminckii*) appeared, and a solitary Swallow (*Hirundo rustica*) was observed. On the last day of the month the Little Bunting (*Emberiza pusilla*), another traveller from the far south-east, appeared. The first few days of June brought the Cuckoo (*Cuculus canorus*), the Great Snipe (*Scolopax major*), the Terek Sandpiper (*Totanus terekia*), and the Black-throated Diver (*Colymbus arcticus*).

In the valley of the Yenesay, about a thousand miles further east, but in nearly the same latitude, very similar phenomena were witnessed. The Snow Buntings and the Redpoles heralded the migrant hosts, and proclaimed the advent of summer and the general break up of the great river. A Swan was seen, however, on the 5th of May; on the 10th, a few Geese; on the 16th (ten days earlier than in the valley of the Petchora), a Swallow arrived. During the remainder of the month, however, little migration was observed, but flocks of Geese and Swans were seen from time to time flying south! These were birds that had been too eager to get on their journey, and were compelled to return to open water far to the south. Summer was at least a fortnight later in Siberia than in Russia, and the Yenesay did not succeed in bursting his ice fetters until the first of June. With the break of the ice on that date migratory birds began to arrive in force, following in the wake of the gradually thawing river. "Although the first rush of migratory birds across the Arctic Circle was almost bewildering," writes Mr. Seebohm, "every piece of open water and every patch of bare ground swarming with them, a new species on an average arriving every two hours for several days, the period of migration lasted more than a month. Very little migration was observable until about the 22nd of May, although a few stragglers arrived earlier, but during the next fortnight the migration was prodigious. In addition to enormous numbers of

Passerine birds, countless flocks of Geese, Swans, and Ducks arrived, together with a great many Gulls and Terns and Birds of Prey."

On the 1st of June, the first small insectivorous bird appeared, the White Wagtail, and the Brambling arrived almost simultaneously. From the 2nd to the 11th, flocks of Shore Larks continued to pass north; on the 3rd, the Wheatear arrived; the 4th brought the Dusky Ouzel (*Merula fuscata*), the Lapland Bunting, the Yellow-headed Wagtail (*Motacilla citreola*), and a great rush of Willow Wrens of no less than three different species, viz. the Siberian Chiff-chaff, the Common Willow Wren, and the Yellow-browed Willow Wren (*Phylloscopus superciliosus*). On the 5th, the Redwing, the Gray-headed Wagtail, and the Cuckoo arrived; whilst from the 1st of June onwards thousands of Swans passed over, all steadily flying north down the course of the great valley to the tundras beyond forest growth. The observations respecting the Bean Goose are particularly interesting, inasmuch that they illustrate very forcibly the progress of Migration in the Arctic regions. "Whenever," says Mr. Seebohm, "the weather was mild during May, small parties of Geese flew over the ship in a northerly direction. When the wind changed and brought us a couple of days' frost and snow, we used to see the poor Geese migrating southwards again. The great annual battle of the Yenesay lasted longer than usual the year that I was there. We had alternate thaws and frosts during the last three weeks

of May. Summer seemed to be always upon the point of vanquishing winter, but only to be driven back again with redoubled vigour. During all this time there must have been thousands and tens of thousands of Geese hovering on the skirts of winter, continually impelled northwards by their instincts, penetrating wherever a little open water or an oasis of grass was visible in the boundless desert of ice and snow, and continually driven southwards again by hard frosts or fresh falls of snow. It was not until the ice on the great river broke up that the great body of Geese finally passed northwards" (*Ibis*, 1879, p. 158). From the 5th to the 19th of June many other small Passerine birds arrived. On the 6th, the Red-throated Pipit and the Scarlet Rose Finch (*Carpodacus erythrinus*) appeared; on the 7th, the Dark Ouzel (*Merula obscura*) and the Little Bunting; on the 8th, the Fieldfare and the Lesser Whitethroat (*Sylvia curruca affinis*); on the 9th, the Sand Martin (*Cotyle riparia*) and the Yellow-breasted Bunting (*Emberiza aureola*); on the 11th, the Siberian House Martin (*Chelidon lagopoda*); on the 13th, the Reed Bunting; on the 15th, the Sedge Warbler; and on the 19th, the Mountain Accentor (*Accentor montanellus*). During this period the great migration of the Waders took place. "The Common and Pin-tailed Snipes (*Scolopax gallinago* and *stenura*) were," writes Mr. Seebohm, "the first to arrive in company with the Asiatic Golden Plover (*Charadrius fulvus*), on the 5th. The Wood Sandpiper (*Totanus glareola*) and Temminck's Stint

(*Tringa temminchi*) arrived on the 6th. The Golden Plover (*Charadrius pluvalis*) arrived on the 7th, and the Ringed Plover (*Charadrius hiaticula*) with the Terek Sandpiper (*Totanus terekia*) on the 8th. The Ruff (*Totanus pugnax*) and the Dotterel (*Charadrius morinellus*) arrived on the 9th; the Great Snipe (*Scolopax major*) on the 11th; and the Common Sandpiper (*Totanus hypoleucus*) on the 12th. On the 15th, the Green Sandpiper (*Totanus ochropus*), the Red-necked Phalarope (*Phalaropus hyperboreus*), and a solitary Curlew Sandpiper (*Tringa subarquata*) arrived. Although migration continued until the end of the month, during which many new species of Passerine birds arrived, I did not add a new species of Charadriinæ bird to my list until we reached the tundras beyond the limit of forest growth."

It would appear, however, that at least one-third of these migrants visiting the North Russian tundras in summer, vary their route somewhat, and do not pass through Ust Zylma, coming by way of the Baltic and White Seas, and thence along the coast to the Petchora delta, leaving the great river at its junction with the Ussa, instead of making the long *détour* south-west which the course of the Petchora here follows, and pushing along the valley of the tributary to the tundras further north; perhaps even passing north direct, and leaving the river system entirely. Seven species of Waders apparently took one or the other of these alternative routes; two Passeres and three Gulls (Laridæ) did likewise.

The possible explanation is, that the individuals of most of these species breeding on the Russian tundras winter more to the south-west, when their normal route would be through Western Europe; or travel from the far south-east by way of the Yenesay and Obb Valleys and across the Urals.

The same sudden character of Arctic migration in spring has been remarked by observers in much higher latitudes. The species are fewer, but they invariably make their appearance simultaneously with the final triumph of summer, an event which takes place even a little later in the season. Captain Feilden, when wintering in the *Alert* in Grinnell Land (lat. 82½°), first observed the Knot (*Tringa canutus*), the Sanderling (*Calidris arenaria*), and the Turnstone (*Strepsilas interpres*) on the 5th of June. Knots were observed, however, a few degrees further south, in the winter quarters of the *Discovery*, on the 31st of May, which practically means that the birds here as elsewhere follow in the wake of retreating winter. On the 9th of June (in lat. 82½°), Feilden observed the Brent Goose (*Anser brenta*) for the first time. In the Arctic regions of North-west America similar reports on spring migration have been made. Thus at Fort Simpson, situated at the junction of the Liard and Mackenzie rivers, about 150 miles north-west of the Great Slave Lake, Mr. R. G. McConnell reports on the spring arrivals of 1888: "The warm weather which commenced on the 1st of May continued throughout the month, and under its influence the snow quickly disappeared,

and the spring advanced with astonishing rapidity. On the 20th of April, the first day the temperature rose above freezing-point for nearly six months, the Barking Crow (*Corvus americanus*) made its appearance. The Raven (*Corvus corax*) had remained throughout the winter. On the 1st of May, some Canada Geese (*Branta canadensis*) were seen at the edge of an open place in the river accompanied by a flock of Mergansers and other Ducks. The 4th brought the Robin (*Turdus migratorius*), and some Sparrows, and on the 5th the Wavies (*Anser hyperboreus*), which usually lag a few days in the rear of the Canada Geese, commenced to wing their way northwards, and in a couple of days were passing in such numbers that flocks were rarely out of sight."

The following table will give some slight idea of the spring migration of birds, half a dozen familiar species having been selected for the purpose of showing the gradual northern movement. (See p. 218.)

The subject of spring migration can scarcely be said to be exhausted until the probable route, and the dates of at least half a dozen stations to denote progress and duration, of every Palæarctic and Nearctic species have been carefully recorded. In the almost complete absence of such data the present chapter can only be regarded as a fragment; but sufficient I hope has been shown to denote the general characteristics of the Spring Migration of Birds, and at least to excite the reader's curiosity, and possibly stimulate him to

SPECIES.	CENTRAL OR SOUTH AFRICA (DEPARTURES).	GIBRALTAR AND SOUTH EUROPE (ARRIVALS).	BRITISH ISLANDS (ARRIVALS).	SCANDINAVIA (ARRIVALS).	ARCTIC REGIONS (ARRIVALS).
1. House Martin (*Chelidon urbica*)	February to April.	February to April.	April.	May.	June.
2. Swift (*Cypselus apus*)	February to April.	March and April.	April and May.	Middle of May.	June.
3. Cuckoo (*Cuculus canorus*)	February.	March.	April.	May.	June.
4. Nightjar (*Caprimulgus europæus*).	Feb. and March.	April and May.	Middle of May.	June.	
5. Common Sandpiper (*Totanus hypoleucus*) ...	February to April.	March and April.	April.	May and June.	June.
6. Sanderling (*Calidris arenaria*)	Beginning of April.	April and May (Passage).	April and May (Passage).	April and May (Passage).	June.

record not only his own observations, but to urge others, suitably placed, to go and do likewise.

From a study of the various facts enumerated in the present chapter, we may gather that Spring Migration is undertaken from an irresistible impulse to breed in a suitable temperature, so far as concerns Species, and that Individuals, with an inherent love for their birthplace and their home, seek such conditions in certain localities each season, returning unerringly to their old haunts, by the old route, such being the only one they know how to follow. Thus the pair of Willow Wrens that nest in a sheltered nook in the distant valley of the Yenesay return just as surely to their old summer quarters so long as life exists within them, and they are able to fly the long journey from Africa; just as surely as the pair of birds that breed amongst the bilberries on the rocky side of a Yorkshire coppice return to their summer home, although the two localities are more than 3000 miles apart! Yorkshire is the Mecca of one pair—of many pairs—just as the Yenesay or any other special haunt within the area of the Willow Wrens' distribution becomes the Mecca of all the rest! Not only are the fly-lines to each great centre different, but the necessities of the journey are utterly dissimilar; and the Willow Wrens breeding in Siberia could no more find their way to English haunts, than could a Sun Bird from South Africa find its way normally to the Yorkshire hills. Migration in Spring may

be said slowly to follow the retreat of winter; in southern latitudes it is much more gradual and broken, just as the grand seasonal change is slower and the summer is long; in higher regions it is rapid and continuous, because seasonal change is quick and the summer is short. In southern regions most migrants are in no great hurry to breed after their arrival—in the extreme south they are remarkably late (later in the basin of the Mediterranean, for instance, than in England); but in the Arctic zone the pent-up sexual passions reach their highest pitch before the summer haunts are open. The young of the Common Sandpiper, for instance, are hatched in England before other individuals of this species reach their Arctic breeding-grounds; so that the moment migrants arrive in the high north they generally begin to breed. If they did not do so, the object of their visit would result in failure. Mention has also been made of the route of Migration varying in spring and autumn; of the change from diurnal to nocturnal flight according to season; but the data on which these statements rest is remarkably meagre, and suggest a wide and useful field for future investigation. In fact the work before the student of Migration is endless, and as enthralling as it is eternal. Our space utterly forbids us to do more than allude to the southern flight of birds during the Antipodean spring, a subject nevertheless of intense interest and importance.

CHAPTER XI.

THE AUTUMN MIGRATION OF BIRDS.

Impulse of Migration in Autumn—Conditions of Migration in Autumn reversed—Migrations of Cuckoos—Duration of Autumn Migration—Difficulty of Noting the Departure of Birds—Direction of Migration Flight—Gregariousness of Birds in Autumn—Autumn in the Arctic Regions—Migration Correlated with Terrestrial Change—Abundance of Birds in Autumn—Minor Streams of Autumn Migration—The Great East to West Wave of Western Palæarctic Migration—Rare Visitants to Western Europe from the East—Concurrent Streams of Migration flowing in opposite directions along the same Routes—West to East Migration in Nearctic Region—Punctuality of Departure in Autumn—Wandering Mania in Young Birds—Table of Autumn Migrants—Reversal of Migratory Impulses in Old and Young.

The Great Autumn Migration of Birds is just as interesting, although it may not be quite so apparent in its earlier stages, as that taking place in spring. The most important impulse of Autumn Migration is unquestionably the failure of food supply; that this Impulse is even more deeply rooted than that which prompts migration in spring is apparent in the fact that All migratory birds, young and old alike, bow to its irresistible dictates. So often and so regularly has the grand

southern Flight been performed, that the impulse is decidedly an hereditary one, as is proved by the fact that young birds and birds whose sexual instincts have been accidentally suppressed, are the first to obey its promptings and to pass south in autumn, just as we have seen that sexual passion being the strongest only in adults sends them first to the north in spring, and that in many cases (if not in all species where the young do not breed in their first spring) the young lag behind. The terrors of that far-off Ice Age, the dismay attending the banishment of Birds from the Polar world, have apparently been so deeply impressed upon migrants, that they have become hereditary terrors—an impulse, a restless longing desire, even in the young and inexperienced, to hurry away to warmer regions at the first possible moment. Curiously enough this impulse appears to be the most strongly developed in birds that breed the furthest north, where the extremes of an Arctic climate are the most pronounced. And what is equally remarkable is, that as soon as these migrants have reached more temperate latitudes they begin to loiter about, and to approach their winter quarters in a more leisurely way, as if conscious that they had left those regions behind where sudden winter might overtake them. We may thus very fairly attribute the Autumn Migration of birds to a fall of temperature at the approach of winter in their breeding-grounds, just as we have seen that the Spring Migration

of birds is due to a rise of temperature in their winter quarters at the approach of summer. On the one hand, the rise of temperature curtails food supply, as well as introduces conditions that render Reproduction, so far as we can learn, either impossible or undesirable; whilst, on the other hand, the fall of temperature and its consequent ice and snow cuts off the food supply more or less completely and compels a southern movement.

In autumn many of the conditions of Migration are exactly reversed. The birds that have the longest journeys before them are the first to start, leaving the high latitudes where they were born, or where they have spent the summer, at the earliest moment. Young Knots (*Tringa canutus*) and young Gray Plovers (*Charadrius helveticus*) begin to pass Heligoland and the British Islands early in August, some even with bits of down sticking to their plumage. Both these birds winter far in the Southern Hemisphere, reaching Australia, South Africa, and South America, with fly-lines more than 10,000 miles in length! Young Sanderlings (*Calidris arenaria*) sometimes arrive on the British coasts at the end of July; their fly-line is equally lengthy, extending to South Africa, South America, and the Malay Archipelago. The Bean Goose (*Anser segetum*), on the other hand, with a fly-line only extending as far south as the Mediterranean basin, China, and Japan, breeds as far north as land is known, yet migrates later, and does not reach its most southern quarters until winter is close

behind it! The Cuckoo (*Cuculus canorus*), with his fly-line reaching from the North Cape to South Africa, migrates early, passing Heligoland in July. In this species, it might here be remarked, the old birds migrate before the young, an anomaly due to the bird's parasitic instincts, which free it from all parental duties, and allow it to set off very early for the south! The Great Spotted Cuckoo (*Cuculus glandarius*) is an equally early migrant, a parasite leaving its summer quarters before its offspring. Indeed it seems doubtful whether these Cuckoos would migrate at all, if it were not for the influence of temperature on the nidification of their eggs, for they just come north to lay them, early in spring, when small insectivorous birds are nesting, and very soon afterwards draw south again. But the Cuckoos that breed in the normal manner are equally normal in their migration. The Yellow-billed Cuckoo and the Black-billed Cuckoo (*Coccyzus americanus* and *erythrophthalmus*) of America are comparatively late autumn migrants, but they build nests and hatch their own eggs in the usual way. It is also interesting to remark that the summer area of Parasitic Migratory Cuckoos is dependent upon that of the various species which play the part of foster parents, and the Migration Flight is consequently affected by the same cause. Were no small insectivorous birds to visit the Arctic regions in summer, the Common Cuckoo would never have extended its range to the Arctic Circle, just as the narrower summer area of the

Great Spotted Cuckoo is controlled by the smaller geographical limits of the species selected to hatch its young and bring them to maturity. The Blackcap (*Sylvia atricapilla*), again, with its comparatively short fly-line, reaching from lat. 60° in Scandinavia down principally to North Africa, and more rarely towards the Equator, is a late migrant, passing Heligoland in October and November. The rule appears to be that the further north a bird breeds, the more anxious it is to get south in autumn, and the longer its fly-line the earlier it is to start. We have already alluded to the fact that some species reverse their routes almost entirely in autumn, and travel south by quite a different fly-line from that they followed north in spring; we have seen that the time in some species is reversed, and night instead of day is selected for Flight. Migration in autumn is also slow and leisurely in comparison with the wild mad rush of spring; birds take their time in moving south, dallying here and there for a few days wherever food is plentiful; taking it easy, as it were; enjoying a well-earned holiday after all the bustle and excitement of summer.

The Autumn Migration of birds in the Northern Hemisphere practically lasts about four months, beginning, we will say, during the latter half of July, and continuing until the first half of November. Some few species wander south later than this, but these must be regarded as Nomadic rather than Regular migrants. Autumn Migration is at its

height during September and October, being much less pronounced towards the extreme dates or periods of its duration. From these facts, and those in the preceding chapter, it will be seen that Migration is more or less in progress during ten months out of the twelve, only lapsing for a period of two months in December and January. As we have already seen, however, even these two months are characterized by certain local movements, so that really migratory birds, generally speaking, can never be regarded as in a state of absolute rest. For various reasons the Autumn Migration of birds is not so observable as that in spring, at least so far as the actual time of departure is concerned. Of course when birds are on direct passage the movement is easily enough remarked along all the recognized routes, species after species passing certain stations with considerable punctuality. It is, however, a very difficult thing to note the exact period of departure from the place where the migration of a species begins. Most birds moult just previous to migrating in autumn, and at that time they become very skulking in their habits, lose their voice, and make a practice of slipping so quietly away that they are not missed perhaps for days after they have really taken their departure. The only reliable sign therefore that migration is in progress is that of individuals actually *en route* at a distance more or less remote from their starting-place. The great wave of Autumn migrants begins to flow south in July, gradually increasing in

volume month by month, until it is in the full tide of its movement, and the temperate zones of the Northern Hemisphere are once more teeming with pilgrim birds. Now the general direction is from north to south, but many pass from north-east to south-west, and from north-west to south-east, the fly-lines crossing each other just as intricately as in spring. In the Palæarctic region we have also a very important stream of Migration flowing nearly due West from the East; another and a smaller stream setting in due East from the West. We shall have occasion again to allude to these various streams of migrants later on. The great intensity of Migration Flight is much more sudden in autumn than in spring, often great numbers of birds appearing at once, not gradually becoming more and more numerous; the ebb is about the same. Another very remarkable fact connected with Autumn Migration is, that the birds observed on passage are much more abundant than in spring, and that the tendency to fraternize among individuals, as well as among species, is greater. Young birds especially are prone to this gregarious habit, and of course it is of these young birds that the great majority of autumn migrants consists. As soon as ever the broods are sufficiently matured to be independent of parental care, a gregarious instinct becomes predominant, especially among Waders, and flocks are soon formed at the common feeding-ground which eventually start off on migration in company. The old birds are delayed somewhat,

by having to complete their moult, but then they too, in a great many cases, pack together and migrate in company. Unfortunately we have not much reliable data respecting the autumn movements of birds in the Arctic regions just previous to migration, but in more temperate latitudes the information is ample. In the Arctic regions the great wave of Autumn Migration is not so apparent in its departure as in its arrival, but further south towards the grand winter quarters, when the flood-tide of this mighty host is gradually accumulating, it is even more apparent than in spring, the points of greatest influx being of course exactly reversed. The first signs of autumn appear in the Arctic regions during August, when the sun drops behind the horizon for a little time every twenty-four hours, his stay gradually getting longer and longer as September arrives. Then the frosts begin, and by the end of that month summer is banished for the year, and the great army of migrants that had collected here from almost every corner of the world, has fled south again, and the land is given up to silence and desolation once more. Species after species for two months has been speeding south; all the old winter quarters in temperate and tropic latitudes have been slowly filling with banished birds, fleeing from the terrors and the hardships of a northern winter; and with the gradual spending of this mighty wave of Avian Refugees the grand phenomenon of Bird Migration completes once more its annual cycle.

Another equally interesting fact concerning Autumn Migration is, that all the more northern birds that appear earliest at their breeding-grounds in spring, as a rule, linger the longest at them in autumn, probably because they are the hardiest and most robust of migrants. The Wheatear (*Saxicola œnanthe*) and the Chiffchaff (*Phylloscopus rufus*), for instance, arrive amongst the earliest of birds throughout their summer area of distribution, reaching the British Islands during the last week in March; they linger in the autumn until most others have departed, being amongst the last to go. On the other hand, the Swift (*Cypselus apus*) and the Red-backed Shrike (*Lanius collurio*) arrive very late in spring (in the British Islands not before May), and are amongst the earliest to retire south in autumn. Probably these very early autumn migrants would be the first to relinquish a northern journey in the event of the summers becoming shorter than they are now, just as the hardy late autumn migrants would continue to visit the northern zones as long as any summer remained at all; or, in the event of warmer climatal conditions rendering the present winters shorter and milder, they would be the first to forego migration altogether. This is another deeply interesting instance of how some of the grandest changes our Planet has undergone are indelibly stamped upon Avian Migration, or are correlated with such a comparatively insignificant phenomenon as the Season Flight of Birds.

The Autumn Migration of most birds is much more marked than in spring, and the vast flocks of certain species that may be regularly witnessed passing to their winter quarters exceed in numbers anything seen in the Vernal movement, even in the Arctic regions. For instance, the Little Bustard (*Otis tetrax*) is described as crossing the Caucasian Steppes on autumn migration literally in millions; the flights of Sky Larks (*Alauda arvensis*) at that season are almost past belief, crossing certain points for days and nights together in one scarcely broken stream. Prjevalsky observed the Needle-tailed Swift (*Chætura caudacuta*) on autumn passage in Mongolia passing overhead for an entire day almost without cessation. The vast hordes of Waders seen on passage are also most characteristic of autumn.

If the predominant direction of Autumn Migration in the Northern Hemisphere is from North to South, many minor streams take a different course. Unquestionably the most important of these is the one that sets in from the East and follows a course nearly due West, in the Palæarctic region. This peculiar, yet very marked, stream of Autumn Migration is as yet far from being perfectly understood, although its existence is a demonstrable fact. It is composed of many species of birds, such as Larks, Starlings, Thrushes, Crows, and Finches, that breed more or less abundantly in Eastern Europe and Western Asia, for the most part hardy species, not exactly obliged to winter in India, or even in North Africa, but forced to leave their

eastern haunts owing to the climate being much more rigorous than in Western Europe, where the influence of the Gulf Stream renders the winters comparatively mild and genial. This great wave of hardy autumn migrants probably begins to flow westwards from the valley of the Yenesay, and drains a strip of country, perhaps 1000 or 1500 miles wide, gradually spending itself in Western Europe and the British Islands, where many of these migrants pass the winter. The route followed appears to be by way of the Aral and Caspian Seas, along the lower valleys of the Volga and the Don, the northern coasts of the Azov and Black Seas, and the valleys of the Dnieper and Danube. Probably throughout its course contingents of birds are from time to time leaving the main artery, and flying south into Persia, Asia Minor, Turkey, Greece, and Italy, as more or less important influxes of the birds forming this stream are remarked at that season in those countries. Many odd individuals of eastern species, whose proper line of migration is south or south-east, get into this western stream of birds and are borne into Western Europe, some of them even reaching the British Islands, Heligoland, and other localities. These lost stragglers are very important indications of this western Migration in autumn. Some of them belong to southern species, but their summer area extends for a considerable distance north in Asia, say into Turkestan and the extreme south of Siberia. Now no northern Migration is known in

autumn in the Northern Hemisphere, yet these southern and eastern birds occur at that season, say in Heligoland or the British Islands, far to the north of any localities they may visit in summer in South-western Europe. In addition to this evidence, we have also the important fact that in cases where a species is composed of two races, an eastern one and a south-western one, the individuals that reach us generally belong to the former race; whilst on Heligoland the total number of stragglers from the south-east of Europe is far more than from the south-west of that continent. There are, for instance, two races of the Black-throated Chat, viz. *Saxicola stapazina*, an inhabitant of the extreme west of the Mediterranean basin, and *Saxicola stapazina melanoleuca*, an inhabitant of the extreme east of that basin, Asia Minor, and Persia. An example of the eastern race has been shot in the British Islands in October. Again, individuals belonging to such thoroughly eastern species as the Isabelline Chat (*Saxicola isabellina*), Richards' Pipit (*Anthus richardi*), the White-winged Lark (*Alauda sibirica*), the Black Lark (*Alauda tartarica*), and Macqueen's Bustard (*Otis macqueeni*), are occasionally brought on this western stream of migration, not only to various parts of western continental Europe, but to Heligoland and the British Islands. None of these birds are migrants to Africa; their winter quarters are in South Turkestan, India, Burma, and South China, but stray individuals take the wrong direction in autumn

and join the western instead of the south-eastern stream of birds. At each period of migration, therefore, whether in spring or whether in autumn, we have the curious fact presented to us of two very important minor streams of migration concurrently flowing from West to East and from East to West along one common route! Rose-coloured Pastors, Rose Finches, and Black-headed Buntings, for instance, on their way from Europe to India, actually pass the western stream of migrants from Asia, with odd White-winged Larks and Richards' Pipits intermingled on their way to Europe! These bye or minor streams of autumn migrants are for the most part a result of extension of area in the species composing them, necessitating a more or less pronounced longitudinal as well as latitudinal flight. Doubtless many other such minor streams remain to be discovered. There can be little doubt that a similar stream sets in from Central Asia and flows south-east towards the coast of North China, the Corea, and Japan, composed principally of hardy birds of eastern origin that have extended their range westwards in summer into the colder climate of Siberia. The Black-throated Divers (*Colymbus arcticus*), for instance, that breed in Eastern Asia migrate east in autumn along the Amoor valley and other well-recognized routes of Passage, to winter in the Japan Sea. The eastern form of the Common Gull (*Larus canus niveus*) leaves its Siberian haunts at the same season, and passes along very similar fly-lines to the coasts of China

and Japan for the cold season. Many Carrion Crows (*Corvus corone*) breeding in Eastern Asia apparently also migrate due east or south-east in autumn to districts on the Pacific sea-board; and it is not improbable that individuals of this species even from South-east Russia and Turkestan take this eastern journey, seeing that the Emigrations of the Carrion Crow in past ages were apparently from a far eastern centre of dispersal, and that its nearest surviving allies are Oriental (*Corvus macrorhyncha*), and even Australian (*Corvus australis*). Probably vast numbers of Larks (the eastern races of *Alauda arvensis: Alauda dulcivox* and *cœlivox*) and other species migrate in autumn along similar routes, but the subject requires much further investigation before we can form any tolerably complete estimate. We also certainly find precisely the same phenomena in the Nearctic region, of birds having extended their area in a longitudinal direction, and migrating in autumn from West to East. Several species of American birds breeding in the Arctic regions of that continent cross Behring Strait into Asia in spring, returning to winter in the southern portions of the Nearctic or the Neotropical regions. Among these birds may be mentioned the Semipalmated Plover (*Ægialitis semipalmatus*), the western form of the Red-breasted Snipe (*Ereunetes griseus scolopaceus*), and the Buff-breasted Sandpiper (*Tryngites rufescens*). This East to West Migration will be further noticed in the following chapter.

Although the fact may not be so apparent as in spring, each species has its regular time of migration in autumn, to which it keeps with wonderful punctuality. Almost to the day birds may be missed in autumn just as we may look for them to arrive on a certain date in spring. This rule, however, can only be strictly applied to adults; the young birds migrate either as soon as they can fly, or begin to wander from their birthplace as soon as they can feed themselves. The movement is generally in the direction of the usual migration. Birds appear very regularly at certain points *en route* in autumn, but generally in more variable numbers than in spring. It is also worthy of remark that the young birds in certain northern species, especially in Nomadic Migrants, wander the furthest south. Everywhere young birds seem possessed more or less with a mania for wandering about. Some of the most extraordinary instances of birds occurring far from their usual habitat, have been those of young or immature individuals—as if on the look-out for new haunts in which to settle; and this, combined with the ordinary migratory impulse, often sends them far from their usual area.

As in the preceding chapter, the following table will give some idea of the Migration of birds in Autumn, the same species being selected to illustrate the return journey. As previously remarked, however, the winter quarters of the House Martin are very imperfectly known :—

SPECIES.	ARCTIC REGIONS (DEPARTURES).	SCANDINAVIA (DEPARTURES).	BRITISH ISLANDS (DEPARTURES).	GIBRALTAR AND SOUTH EUROPE (DEPARTURES).	CENTRAL OR SOUTH AFRICA (ARRIVALS).
1. House Martin (*Chelidon urbica*)	August and Sept.	September.	Sept. and Oct.	Sept. to Nov.	Oct. and Nov.
2. Swift (*Cypselus apus*)	August.	August.	August and Sept.	Sept. and Oct.	Oct. and Nov.
3. Cuckoo (*Cuculus canorus*)	July.	July.	July and August.	August and Sept.	Sept. and Oct.
4. Nightjar (*Caprimulgus europæus*).		August and Sept.	September.	Sept. and Oct.	October.
5. Common Sandpiper (*Totanus hypoleucus*) ...	August and Sept.	August and Sept.	August to Oct.	August to Oct. (Passage).	Sept. to Nov.
6. Sanderling (*Calidris arenaria*)	August.	August and Sept. (Passage).	August to Oct. (Passage).	Sept. to Nov. (Passage).	Sept. to Nov.

From the above remarks we may conclude that the Autumn Migration of Birds is initiated by a fall of temperature and consequent failure of food, in conjunction with an unquestionably strong hereditary impulse to move south from regions where ages of accumulated experience have taught that a winter sojourn means death. Young birds seem more strongly impelled to migrate in autumn than in spring, seeing that in so many species they not only leave before their parents, but are more or less reluctant to quit their winter quarters the following spring. On the other hand, the impulse in old birds to migrate in spring is stronger than in the young, owing to sexual instincts being so much more highly developed. The impulse to migrate in young and old seems exactly reversed according to season. In Autumn the Young are the eager ones, the Old the laggards; whilst in Spring the Old are the eager ones, and the Young are the laggards. The Migration of Birds in Autumn follows in the wake of retiring summer and in the van of winter, just as in spring it follows in the wake of retiring winter and in the van of summer. Migration in Autumn in the Southern Hemisphere, so far as we can judge from the scanty details on record, is of a very similar nature to that prevailing in the Northern Hemisphere, and initiated by exactly the same set of causes, namely, failure of food in consequence of a fall of temperature.

CHAPTER XII.

MIGRATION IN THE BRITISH ISLANDS.

Diverse Character of Migration in the British Isles—The Researches of Messrs. Harvie-Brown and Cordeaux—Migration Reports Published under the Auspices of the British Association—Migration at British Lighthouses and Light-vessels—Routes of Migration in British Isles—Effects of Rocky Coasts on Migration—Recognized Points of Ingress—Classification of British Migrants—Migration and Wind—Spring Migration in British Isles—The First Flights—Rushes in Spring—Cross Migration in Spring—Effects of Temperature—First Arrival of Summer Birds from South—Spring Migration at the Eddystone—Commencement of Autumn Migration—Its growing Intensity—Change of Direction in Migration Flight—The Eastern Wave of Autumn Migration—Number of Species composing it—Correlation of Migration on Heligoland and British Isles—Autumn Migration of Goldcrests—Autumn Migration of Starlings—Vast size of these Autumn Bird Waves—Their persistency—Migration of Hooded Crows in Wash District—Mortality among Migrants—Origin of East to West Migration—Birds declining to Cross the English Channel—Cross Migration in Autumn—Migration along South Coast of England—Winter Migration—Species Migratory all the Year round—Birds foretelling Snowstorms—Influence of Migration Movement on Species—Tables showing the Duration of Flight of British Migrants.

Perhaps no other part of the world is more admirably situated for the study of Migration than the British Islands. Almost every known kind of

Avian Season Flight may be witnessed upon them. They are the summer quarters of vast numbers of birds; the winter rendezvous of others. They are situated on the direct fly-lines of many northern birds that pass over them in spring and in autumn to breeding-grounds in the Arctic regions and to winter haunts in the Tropics. They are visited by birds that fly north during the Antipodean winter; by birds that come from the far East, and not a few from the trans-Atlantic West. Much Nomadic Migration breaks upon them; whilst the rare birds obtained on abnormal flight within their area equals, if it does not exceed, in number and in interest, the occurrences in any other part of the world. Not only so, but Migration in the British Islands is of an unusually diverse character, remarkably universal, and subject to all those fluctuating incidents that until the last few years were presumed to be peculiar to one European station alone. The fact is, Migration was never studied in our islands at all, except in the most cursory manner, until two British ornithologists, Messrs. J. A. Harvie-Brown and J. Cordeaux, went to work in the only practical way, by enlisting the aid of persons stationed at lighthouses and light-vessels, and best situated for watching and reporting the Season Flight of Birds. British naturalists are very deeply indebted to these gentlemen, for it is to their labours that the systematic study of Migration in the British Islands is almost entirely due. For several years unaided they published returns on Migration from numerous stations round

our coast in the *Zoologist* and elsewhere. In 1881 the investigation was countenanced and authorized by the British Association for the Advancement of Science, and a Committee appointed to carry on the work, and make annual reports thereon. Gradually the area of observation has been extended, until the stations numbered upwards of two hundred. Nine Annual Reports have been compiled chiefly from schedules sent in by light-keepers, dealing not only with the customary spring and autumn migrations for every year, but with much evident Local Movement and Nomadic Migration. The result is an immense amount of information—of raw material, from which it may be possible to obtain some important facts, but the labour will require very great care and discrimination on the part of the compiler, who must also have a keen appreciation and extended knowledge of Migration as a whole. To attempt wide deductions on Migration Philosophy from this mass of raw localized material will end in failure. It is evident in many of these reports that too much importance has been attached to what are purely local and fortuitously initiated movements, and that many of the birds referred to are not flighting at all in any sense of the term.

Be all this as it may, however, we are now furnished with abundant evidence that Migration over the British Islands prevails to a very astonishing but previously utterly unsuspected extent. No longer does Heligoland stand alone in its Migration importance; scenes just as wonderful and just as

frequent may be witnessed from scores of stations in the British Islands likewise. In many cases Migration is even more marked on our eastern coasts than on Heligoland. This is only just what we ought to expect. Had Heligoland retained its unique character as a Migration Station, much of the mystery in Avian Season Flight that is now made plain would only have been intensified. Many of these simple and obviously truthful British Migration Reports read like romance, and equal anything that has come from the famous bird rock at the mouth of the Elbe. Birds striking the lights; birds in countless hosts, drifting by in feathery tides; birds in hundreds exhausted and falling into the sea to perish, or allowing themselves to be taken by the hand; birds passing for days together, literally square miles of them; birds by day and birds by night, flying in regular steady waves or in bewildering rushes; birds following the rays of revolving lamps, or hurling themselves against the dazzling beacons to die, or settling in crowds to rest! Such are the facts observed by the light-keeper on his lonely vigil, and forming a chapter in the life history of our feathered friends of profound, intense, and marvellous interest! When we bear in mind that the records of Heligoland have been religiously kept by a distinguished naturalist for half a century, and that our reports are made almost in every case by untrained and unscientific observers, the possibilities of future research seem limitless.

To deal fully with the subject of migration in

the British Islands, it will be necessary to recapitulate at least a portion of our earlier chapters. The first portion of the subject on which it becomes necessary to dwell is that of Routes. Undoubtedly the most important Highways of Migration in the British Islands are along the coast-lines. This is very forcibly expressed by Mr. Cordeaux: "An observer taking up his position at a short distance from the coast would see or know nothing of Migration, yet within half a mile or less there might be a constant stream of birds, hour by hour, and day by day, passing to the south." This is probably owing to the small area of the islands, and the coast-lines trending almost entirely from north to south—a direction favouring passage not only for species breeding or wintering in this locality, but for those birds that pass along them during spring and autumn flight. Undoubtedly the most important of these extend along the east and south coasts, and drain a considerable migration from Scandinavia by way of the Shetlands and Orkneys. At the latter, the route seems to branch into two, one following the west coast of Scotland, including the Hebrides, to the north of Ireland, where another branch occurs, the western following the Atlantic seaboard (a route little traversed by Passerine birds); the eastern, the coasts of St. George's Channel, the Irish Sea, and the Bristol Channel, along which highway great numbers of small birds pass from the south, and *vice versâ*. These Routes may be roughly taken as the general direction of

migration, but they are subject to an immense amount of local modification. Thus all or nearly all the great indentations of the coast are skipped by land birds (Waders keep much more closely to the windings of the coast, especially such as afford suitable feeding-grounds), which make a practice of flying from one headland to another. The normal fly-line, for instance, down the west coast of England from Scotland misses all the English coast-line of the Irish Sea, and crosses from the Mull of Galloway, *viâ* the Isle of Man to Anglesey. In the same manner many of the wide Scottish Firths are crossed, as well as many of the more important promontories. Doubtless these practices are general among migrants throughout the world, for there is nothing to lead us to presume that the British Islands are abnormal in this respect. One or two local lines of Migration have also been indicated, such as across the narrow country between the Firths of Clyde and Forth; and across England from the Wash to the Bristol Channel, onwards probably to Ireland.

Owing to the much more rocky character of the east Scotch coast-line than that of the east of England, the waves of Migration are more or less compressed into the various Firths and river-valleys, which serve as the passages to and from the inland districts, such as the Pentland and Moray Firths and the Firth of Forth. On the eastern coast of England, where the sea-board is low, a more general ingress and egress is made, although there is

certainly some evidence that the valleys leading from the Humber, the Wash, and the Thames are feeders for the more inland districts. That the Humber and the Wash are favourite routes to the interior, I have gathered much evidence to prove, mostly from personal observation. The Goldcrests (*Regulus cristatus*) that strike the Humber district in autumn, sometimes in enormous rushes, may be traced right up the valleys of the Don and Sheaf and Trent almost to their source. The Song Thrush (*Turdus musicus*) follows a similar course, as also do various Waders and Crows. The Hooded Crows (*Corvus cornix*) that in equally large flights strike the Wash district may be traced along all the river-valleys, the Witham, Welland, Nene, and Ouse into the adjoining counties. For some reason not at present quite clear, birds prefer to enter or leave the country *viâ* a depressed coast, often following below a long line of cliffs (perhaps for shelter) until a more suitable district is reached. This is essentially the case along the rock-bound south coast of England, where Mr. Swaysland assured me many years ago that migrants made a practice of "cuddling the cliffs," and as I have myself on various occasions witnessed both in autumn and in spring. This was in the vicinity of Brighton. Further west in Devonshire, I am of opinion that the Dart valley is another important gateway of migratory birds. From Dartmouth to Berry Head the coast is very precipitous, and but little migration appears along it; but migrants

enter the Dart valley and spread over the surrounding country right up to the shores of Tor Bay, often in surprising numbers. I have traced the migration flight of Cuckoos, Warblers, Redstarts, and Flycatchers along this route in spring. It has also been remarked that migrants coming into our islands in autumn seldom or never alight on the coast after a favourable passage, but fly inland at once, which I, myself, have often witnessed in the Wash and elsewhere. On the other hand, if the journey has been rough and fatiguing, the migrants are glad to drop on the nearest land, often tired out and utterly exhausted. I have seen Goldcrests and Linnets (*Linota cannabina*) swarming in thousands in the Lincolnshire salt-marshes, many of them so tired and exhausted as to fly with the greatest reluctance.

Although I am very strongly of opinion that all or nearly all our indigenous birds are more or less migratory, what we will designate the British migrants proper may be divided into three very distinct classes. First, we have the birds that come here in spring to remain with us during the summer and rear their offspring; second, the birds that come here in autumn to spend the winter with us and leave in spring; and third, the birds that only pass our islands to and from the more northern breeding-grounds and more southern winter quarters. Perhaps we might also add a fourth class, consisting solely of Nomadic Migrants, whose appearances are irregular and intermittent, yet often

very considerable, and in many cases composed of individuals of various species driven from one part to another by stress of weather. The usual marvellous punctuality of arrival and departure, and persistency of following certain routes; the same order of Migration; in fact all the minor details of Flight are observed by British Migrants as we have seen is so universally the case in earlier portions of this work, so that they need not be more than alluded to again. We might also, however, remark similar obedience to Meteorological changes and choice of Flight wind. The evidence so far as it goes seems to imply that direction of wind is subservient to a very great extent to change of temperature, the latter, if adverse, initiating Migration even in the face of contrary or unfavourable air-currents. The consequence is, that the prevailing winds at the time of Flight, especially in autumn, influence to a great extent the wave of migrants, deflecting it in certain directions, and causing it to be of a broad and expansive character, rendering the tide gentle and continuous, or compressed and narrow, rendering it more throbbing and in occasional rushes.

We will now proceed to glance briefly at each of these great classes of Migrants, beginning with those in spring. Migration at this season begins almost as early in the British Islands as in South Africa, but of course the species affected are very different. The first decided migratory movement is noticeable, say in February, when various birds

that have been wintering in this area begin to pass towards the continent. The most noticeable of these are such species as Blackbirds (*Merula merula*), Thrushes (*Turdus musicus*), Redwings (*Turdus iliacus*), Fieldfares (*Turdus pilaris*), Pied Wagtails (*Motacilla yarrelli*), Meadow Pipits (*Anthus pratensis*), Larks (*Alauda arvensis*), Rooks (*Corvus frugilegus*), Hooded Crows (*Corvus cornix*), various Finches, such as House-sparrows (*Passer domesticus*), Linnets (*Linota cannabina*), Redpoles (*Linota rufescens* and *linaria*), and Snow Buntings (*Emberiza nivalis*). All these birds continue now at intervals to pass out of our islands for the next two months, sometimes leaving in considerable flights which last almost incessantly for days together; whilst as the spring advances, Starlings (*Sturnus vulgaris*), Goldcrests (*Regulus cristatus*), and other birds begin to move, and the great departure of Ducks (Anatidæ) and Waders (Charadriidæ) commences. Many of these birds compose the great autumn wave of Eastern Migrants, but the numbers that return in spring are rarely so marked. Instances of great vernal rushes, however, have been recorded. For example, it is reported from the Swin Middle Light-vessel, stationed some twelve miles off the Essex coast, that on the night of February 14th to 15th, 1885, great numbers of Larks were passing towards the south-east; ninety of them came on deck, numbers fell into the water, and "for two hours the Larks were like a shower of snow." These birds were evidently migrating out of England

towards the coast of Belgium, on the old route back to the East. Another very important migration, chiefly of these early migrants, is also, incredible as it may appear, actually coming into England *from* the Continent at the same period; so that we have the astounding phenomenon of a marked and constant Migration across the North Sea in exactly opposite directions! These latter migrants are birds that evidently breed in our islands, but for some reason prefer to winter on the Continent. This movement may be due to the influence of Temperature varying on individuals of the same species. The Crows, Starlings, Larks, Buntings and Finches spending their summer in Great Britain, may require a higher winter temperature, and retire towards Southern Europe to obtain it; whilst those from the colder east and north area of continental land, and naturally of more robust constitution, find the temperature suited to their individual requirements in our islands. In autumn this Cross Migration may in part be due to the stream of migrants from North-western Europe, which passes along our coasts to the south, meeting the east to west stream of migration, composed of birds on their way to winter with us. Whatever the dominating cause, the fact is unquestionable, and the Cross Migration is not only regular but persistent, especially during seasons remarkable for great and sudden changes of temperature. I firmly believe that temperature, *as affecting individuals*, is the chief initiating cause of these singular Avian waves, and that their ebbing

and flowing is not voluntary, although Mr. Cordeaux appears to be of the opinion that it is. The necessities accruing in past ages, and handed down as hereditary impulse, may also be a minor cause.

Whilst the latter part of all this spring migration is going on amongst birds that have either wintered with us, or only left our shores to seek more genial winter quarters in the immediate neighbourhood of the continent, the regular northern migration of birds from the far south, from the Mediterranean basin and Africa, begins; perhaps with the advent of such birds as Wheatears (*Saxicola œnanthe*), Chiffchaffs (*Phylloscopus rufus*), and Woodcocks (*Scolopax rusticola*), towards the end of March, although instances are on record where a few *avant courières* of the former species have been remarked in the north of England during the last week in February. With the advent of April, Migration becomes much more intense; as the month progresses species after species pours in from the South: delicate Warblers, Redstarts, the Cuckoo, the Wryneck, all the British Hirundines, Tree Pipits, and so on; together with a steadily increasing stream of Waders, including the Common Sandpiper; also various species of Terns. Less intensity characterizes Migration of British individuals in May, although a vast number of birds are passing our islands during that period, on their way to the Arctic regions. During this month the last batch of our regular summer visitors make their appearance, which includes the Garden Warbler, the

Spotted Flycatcher, the Nightjar, the Swift, and the Turtle Dove. As an instance of the important stream of migrants still passing north, we learn, as reported from the Eddystone Lighthouse, on the last night of May, 1887 (cloudy with mist and drizzling rain), that a Cuckoo was caught at the lantern at 10 p.m.; that flocks of Sandpipers (some individuals striking the light), Swifts, Swallows, Wheatears, and Warblers continued to pass from midnight till 3 a.m., or just in the gray dawn of morning, great numbers of the last-mentioned birds being killed against the lantern! By the first week in June Spring Migration over the British Islands has practically ceased, having prevailed to a more or less extent for about four months.

Scarcely have the last spent pulses of the Great Vernal Wave of Migration ceased to flow upon the British Islands before the first ripples of the Autumn tide begin to be apparent. By the middle of July the Autumn Flight is inaugurated with the arrival of the first Arctic Waders, either seen flying south along our coasts or off them at sea, or heard even at some distance inland crossing at great heights over the star-lit sky. As we have already had occasion to remark, a few old birds invariably herald the rush of young. By the end of the month and early in August the arrivals are more numerous; young Knots and Gray Plovers, Common Sandpipers, Lapwings, Ringed Plovers, Greenshanks and Curlews. Small birds such as Swifts, Wheatears, Willow Wrens, Wood Wrens, and

Whinchats, the young predominating, also begin to pass during this period, doubtless from more northern breeding-places. Right through August the great wave of Migration is slowly gathering in force, birds becoming more and more numerous on our coasts, whilst our own summer birds are beginning to gather preparatory for flight in littoral as well as in more inland districts. But little Migration takes place among our familiar summer birds during August, however, notwithstanding the steady influx of birds from other lands. Many of our young Swifts and most of our old Cuckoos, however, move south in August; most of our other summer migrants are now moulting; all are songless, and much more skulking in their habits than usual. Swallows and Martins begin to pack, and very early in September a considerable number of young birds depart south. During this month the migration of various soft-billed or insectivorous birds becomes much more intensified. Everywhere Warblers, Swallows, Wheatears, Flycatchers, Ring Ousels, Thrushes, Wagtails, and such-like species are all speeding south, whilst the number of Wading birds is very perceptibly increased. Especially is this the case among Arctic species, such as Curlew Sandpipers, Knots, Stints, Turnstones, Godwits, Dunlins, Gray and Golden Plovers, a few Ducks and Geese. Terns in flocks (principally young birds) are also now moving south. At the beginning of the month the migrants are mostly composed of young birds, especially among the

Passeres, but towards the end a perceptible preponderance of adult birds is noticed. At intervals a general rush of one or two particular species will be noted; one night it is Willow Wrens, Whitethroats, Tree Pipits, and Sedge Warblers; another night Thrushes, Wagtails, Flycatchers, and perhaps large flocks of Plovers, Dunlins, and Swallows, with an odd Woodcock or a Corn Crake, or a little party of Robins and Meadow Pipits. No particular hour seems chosen by each migrant: all are hurrying along the great highways which are the common property of each. By the beginning of October the great majority of our summer birds are gone; little more than the last lingering flocks of Swallows remain behind. Many of the hardier birds continue to pass our coasts, however, to more southern latitudes, such as Buntings, Thrushes of various kinds, Meadow Pipits, Larks, and Starlings; and now the great autumn influx of birds coming to the British Islands to winter continues day by day to swell in volume. Waders and Water Birds still continue to pass south, striking our coasts from the north-east, and following the shore on their way, or pass over more inland at great altitudes; others arrive to winter upon them. By the end of October the last of our own summer migrants have gone, and our avifauna assumes quite a different character.

Up to the end of September the general stream of Migration breaks upon our islands from the North-east, then a very perceptible change of direction takes place, and the predominating line of

Flight falls to nearly due East, or points south of East. This is the first sign of that gradually approaching Eastern Wave of Migration which trickles rather than flows until (on an average) the middle of the month. Then it suddenly assumes a more powerful flow, culminating in a grand and mighty influx of birds (young predominating), lasting almost incessantly for perhaps a fortnight; then a lull of a week or so occurs; and then another grand wave of not quite the same magnitude and duration (adults predominating) breaks upon our eastern sea-board; after which the Migrant Tide is more or less spent for the year, having drained the greater part of Western Asia and Eastern Europe of the majority of their hardiest non-insectivorous birds!

This westerly flowing tide of migrants is perhaps the most interesting Avian movement that takes place in our islands, because it is so enormous and so palpable to every eye. The number of species borne on its swelling stream is not very great, normally, but the number of individuals is almost past belief, and what is also to be remarked, they are all birds of exceptionally high powers of flight. Indeed this migration must be seen to be believed; and a visit to our low-lying eastern coasts about the middle of October will rarely fail to convince the observer of its overpowering and bewildering vastness. Night and day the inrush of Migrants is constant and prodigious. For weeks I have repeatedly watched this marvellous Avian movement

on our eastern seaboard until almost bewildered by the steady throbbing rush, rush, of arriving birds. Thrushes, Larks, Goldcrests, Finches, Starlings, Crows, Rooks, and Ring Doves comprise the bulk of these migrants; but many other species arrive in smaller numbers, and now and then a rare straggler whose route has been abnormal. It is very interesting to trace the approach and arrival of these great Bird Waves, advancing from the continent to our Islands. Here, for instance, is the movement of a very important wave from east to west during the night of October 15—16th, 1885, traced from Heligoland across the North Sea to the British Islands. We find Gätke at his island station of Heligoland making a note, referring to the morning of the 15th, that the weather was favourable for an important migration—Thrushes and Woodcocks especially—the wind S.E., the weather clear; but owing to the strong westerly currents prevailing in the higher atmosphere, the impending flight did not take place, or was not visible from the island. In the evening the wind rose and changed to E. by N., with clouds from the S. and E., whilst in the night it backed to the E. with thick clouds from the S.E. During the day, however, Jackdaws and Hooded Crows, as well as Thrushes, Pipits, Larks, Buntings, Jack Snipes and Chaffinches were observed on passage, the latter birds flying in thousands, but so high as to be invisible, and only distinguished by their notes; in the night the impending bird stream passed by,

and Gätke records an extraordinary strong migration of Larks, Thrushes, Starlings, Curlews and Plovers. On the 16th, in similar weather, "an extremely strong migration of Thrushes, Larks, Finches and Starlings" is recorded.

Here now are a few reports made on the same dates on the East coast of England, with the weather overcast and misty, and the wind E.N.E. From the Farne Islands we hear of a great rush of Fieldfares night and day, and of similar rushes at the Dudgeon Light-vessel off the Wash, 200 miles further south. We also hear of very large arrivals of Blackbirds by day and night striking the entire eastern coast-line of England from October 15th to the 18th; further, that Chaffinches arrived mainly in two large Flights between October 12—16th; that a very heavy immigration of Skylarks took place, the bulk of the birds arriving in enormous rushes on October 15th, 16th, and 17th; that enormous numbers of Starlings arrived from the 12th to the 19th, and large numbers were killed at the lights; that an almost continuous rush of Hooded Crows and Rooks appeared from the 15th to the 17th, between the Humber and Thanet.

Again, in the autumn of 1884, Gätke records on October 24th (clear and fine, with wind S.E.), "monstrous" numbers of Rooks, Hooded Crows and Jackdaws, the two latter species passing in mixed flights of ten and twelve minutes each, with short interruptions or gaps, the flocks extending as far as the eye could reach north and south from

9 a.m. to 1 p.m. A "succession of clouds" of Starlings also passed by overhead. On the East coast of England similar inrushes were remarked on days exactly corresponding. Again, in the same autumn we find that "immense rushes" of Starlings appeared on our eastern coasts during the latter half of October, by day and night. At Heligoland, Gätke remarks of this species: "enormous numbers" crossed between the 14th and 25th, especially on the 19th, "immense numbers"; on the 20th, "clouds of enormous numbers"; 21st, "astounding"; 22nd, "astounding flights, like clouds passing on." The autumn influx of Goldcrests is even more astonishing, when we bear in mind that this bird is the smallest Palæarctic species. From the Isle of May to the Channel Islands broad waves of this migrant strike our eastern and southern coasts, in varying numbers. In the autumn of 1882 this little bird reached Western Europe in marvellous numbers. Right through October they continued to arrive in enormous multitudes, two rushes being very pronounced, one on the night of the 7th and the morning of the 8th, the other on the night of the 12th and the morning of the 13th. At Heligoland, on the 28th and 29th, Gätke records: "a perfect storm of Goldcrests we have had—poor little souls! —perching on the ledges of the window-panes of the lantern of our lighthouse, preening their feathers in the glare of the lamps; on the 29th, all the island swarmed with them, filling the gardens everywhere,

and over all the cliff—hundreds of thousands; by 9 a.m. most of them had passed on again." How many of these little pilgrims fell by the way man may never know, but undoubtedly the great majority never returned to the land of their birth! The rush of Starlings and Sky Larks across the North Sea in autumn especially is simply incredible. For days and days together the Larks may be watched coming into England in a scarcely broken stream by day, and their warbling cries fill the air at night as the great tide still flows on. Here is Gätke's description of the migrating Starlings in the autumn of 1883. On October 6th, "in astounding flights, thousands upon thousands"; 12th, "considerable numbers of astounding flights, both overhead and in distance"; 13th, "still passing, astounding numbers all day"; 26th, "ditto, very high"; 27th, "night from 11 p.m. myriads"; 28th, "immense." Correspondingly large waves of these birds struck our coasts, and might be described in similar terms.

We might thus go on dealing with species after species in the same manner, but the limits of our space forbid. Nevertheless these few intensely interesting facts speak for themselves, vividly and eloquently telling of that great Avian influx across the wild North Sea. It is, however, worthy of remark that in many cases vast waves of migrants breaking over our islands do not touch Heligoland at all, as is proved by the fact of enormous rushes reaching our eastern coast-lines on days and nights

when little or no Flight has been remarked over the famous island. The same remarks apply to our own islands; great waves and rushes being witnessed on the western or northern coast-lines, and scarcely any to correspond with them on the eastern, which clearly seems to demonstrate how wide and vast are these feathery tides, only breaking here and there on the coast, owing to local influences. The width of some of these vast east to west Bird Waves is enormous; they have been known to break almost simultaneously on our shores from the Faroes or the Shetlands and the Orkneys in the north to the Channel Islands in the south, a distance of some 900 miles; how much further they may have extended north and south remains a mystery! Gätke, writing on these Avian Waves, on October 6th, 1883, with a N.E. wind and clear fresh weather, remarks: "Across the sea both sides of island (N. and S.), particularly on north side, countless numbers of *cornix* [Hooded Crows], *sturnus* [Starlings], and all kinds of small birds, all from E. to W. This occurrence happens not rarely; during this ponderous migration there were on the island nearly no birds." Some of these Bird Waves are very persistent, for days and even weeks together, but normally the East to West autumn migration breaks principally upon our shores in two great floods, the first during the second and third weeks in October, and the second about a month later. The migration of each particular species in this great Avian wave varies considerably

from year to year; sometimes it is completed in a few weeks, sometimes it extends over as many months. It is also worthy of remark how suddenly Migration will sometimes commence or cease. I have seen migrants coming for several days across the North Sea to the Wash—Larks especially—and for say three or four hours every morning, or all night, up to 10 or 11 a.m. the stream would flow, and then cease for the day. Hooded Crows often do this, migrating for days together in the morning. The first scattered flocks may be noted soon after sunrise; many alight on the mud-flats to feed or to rest, but the majority pass on to more inland districts, or set a southerly course along the coast-line. The irregularity of their appearance is sometimes remarkable. First perhaps an odd bird or so comes along; then in a few minutes a party of eight or ten; whilst at longer intervals occasional flocks appear, all flying in a slow, laboured, yet powerful manner, the individuals scattered about with no apparent approach to order.

The Mortality among these mighty bird hosts must be appalling, stupendous! The thousands of these pilgrims of the night that yearly kill themselves against the lighthouses and light-vessels round the British coasts represent a mere trifle in the general rate of mortality; the greater number perish at sea! In any case the sadly significant fact is only too apparent that only a fragment of these bird swarms—countless, one was going to say, as the sands on the shore—returns in spring.

Where they go and what their ultimate fate is a matter shrouded in mystery! It teaches us, however, to realize the fecundity and the mortality pertaining to Avian Life.

The origin of this great East to West Migration Wave must undoubtedly be sought in long-past ages. That the movement is a deeply-rooted one is evident from the persistence with which it is undertaken, even by some few species of comparatively weakly flight. Doubtless it originated from a prevailing low winter temperature in Eastern Europe and Western Asia, and a comparatively high winter temperature in Western Europe owing to Gulf Stream influence. Had it not been for the latter current this great Wave would undoubtedly have drifted South instead of West. That this difference of temperature exists is a fact no one will attempt to gainsay. The winters of South Russia and South-west Siberia, in the same latitudes as the South of France, are as remarkable for their normal severity as the winters of West Europe within the same parallels of latitude are for their normal mildness. That this is due to the warm ocean current that flows along the coasts of the latter is also an undoubted fact. There can be no doubt whatever (after what we have already learnt of Migration) that this difference of climate has had a marked effect on Avian life, and been the initiating cause of this East to West Migration Flight. Now in remote yet Post-Glacial Ages, the British Islands, the entire German Ocean, the English

Channel, and parts of the Bay of Biscay formed one land mass connecting with Scandinavia by way of the Shetlands, and extending south-west round the south of Ireland to the south-west of France. Migrants then reached this portion of Europe without having any sea-flight at all; it was simply an overland journey to the mild coast regions of continental land—the vast bulging west peninsula of Europe. But great submergence has taken place; the North Sea, the English Channel, the Irish Sea have been formed, and great areas of land have sunk along the Atlantic sea-board, leaving matters as we now see them. The stream of Migration, however, continued—the custom of visiting these mild western regions was too deeply rooted a custom to be relinquished; and not even the widening area of gradually accumulating sea has succeeded in stamping it out. In those far-off days the difference of climate was evidently even more acute than it is now, as is proved not only by geological evidence, but by the still surviving relics of a flora in the south of England and Ireland that belongs decidedly to Italy and the South, rather than to Scandinavia! We have seen in earlier portions of this work how birds still continue to follow submerged routes; across that ancient Lemuria, for instance, now lying beneath Indian Ocean waves; we have in this East to West stream of Migration another instance, although on a smaller scale, and consequently followed by many more species than travel by that submerged route

between India and South Africa! We might here also allude to the interesting fact of several birds being regular summer migrants to France and Holland, and yet never visiting the British Islands, except perhaps as stragglers on abnormal flight. The Great Reed Warbler (*Acrocephalus turdoides*) and the Blue-headed Wagtail (*Motacilla flava*) may be cited as particularly good instances of birds common enough across the English Channel, yet as rare in our islands. I am of opinion that these birds did not extend their emigrations or migrations so far north in Western Europe before our islands became detached from continental land; they are more recent emigrants which found the English Channel a barrier to any further western extension.

There are one or two other matters to which we must allude ere dismissing the present subject. First, it may be as well to glance at the Cross Migration taking place in autumn, just as we remarked it in spring, only of course the direction is exactly reversed. A very interesting instance of this peculiar Flight is reported on the 17th of October, 1885, from the Isle of May Lighthouse in the Firth of Forth. We cannot do better than let Mr. Agnew the light-keeper speak for himself. "A great rush of migrants at Isle of May. The Woodcock was killed on the S.E. side, and the other birds on the N.W. side. Thus the migrants have been exactly meeting one another; and this is just as I would have expected—the Woodcocks *coming* to us, and the others *leaving*

us." Now this is an intensely interesting fact, and confirms very strongly our opinion above expressed, that in some cases at least the birds flying south are merely passing our coasts on passage from North-Western Europe; for among the species that struck on the N.W. side in this instance was the Redwing, clearly demonstrating that in this case the northern stream was on its normal way south *vid* the British coasts, and was not composed of our own birds leaving us to winter further south. Whinchats and Willow Wrens were also in the stream—species the individuals of which breed in Scotland normally leave that district, say in September. A similar Cross Migration is also apparent during autumn in the south-western portions of the North Sea.

We have also the same facts presented to us of Migrants waiting for favourable winds; and on the south coast of England the same double streams of birds, one passing nearly due east to the Straits of Dover, composed of various kinds of summer migrants on their way south, passed by another stream of hardier birds coming into our islands for the winter, and passing as nearly due west.

It remains for us now to notice the various Winter Migrations passing from the continent to our islands, or Local Movements among the birds wintering with us. Changes of temperature are the great initiating causes of these minor waves of Nomadic Migration, and some of the rushes which then occur are both interesting and important. Thus severe weather in

the northern districts will send thousands of Larks, Snow Buntings, Finches, Crows, and Starlings drifting along the coasts towards the south. At the Galloper Light-vessel, stationed off the mouth of the Thames, we have a very interesting instance of this Nomadic Migration, taken from scores of similar instances. On the nights of January 21st to 23rd, 1885, no less than 226 birds were killed, all refugees from a severe spell of winter in more northern districts. We have many instances where our eastern coast districts have swarmed with Snow Buntings and other hard-billed birds, and of spasmodic arrivals of others from the continent during exceptionally hard weather, which will, as any observer may remark, clear a district of birds very quickly for the time. In fact, all the winter through Nomadic Migration is in progress on no uncertain scale. Birds are constantly passing to and fro, now sparingly, now in bewildering numbers; from every point the same story comes, proving absolutely that at least some species are actually in a constant state of passage through every month of the twelve. In Larks and Starlings this fact is specially noticeable. Some birds are certainly more highly susceptible to a change of weather than others, especially those that obtain their food from the ground. Lapwings, Larks,[1] and Snow Bunt-

[1] It may be for this reason that Larks always prefer a winter haunt on the highest ground in the district they frequent, where a coming change of temperature is probably more readily and quickly detected than in the valleys. My invariable ex-

ings will unerringly foretell a snow-storm hours in advance, and commence a nomadic migration to escape its dangers. From all this constant Passage one vastly important fact may be deducted. It shows us how the individuals of a species are kept well intermixed, and thus furnish those all-necessary facilities for interbreeding that are the dominating influences in preserving those species, and keeping them up to their normal standards of constancy.

We would fain have entered more fully into the Migration of British birds, but we are compelled with reluctance to confine our chapter to the limits it has now reached. It would have been a very easy matter to fill our volume with the stirring story of their movements alone; but we trust that sufficient has been said to make the whole subject of Migration reasonably and tolerably complete, notwithstanding its unavoidable meagreness. The following tables will give the reader some idea of the general movements of birds in the British Islands.

The student will also find appended Blank Tables for the next eight years in which he may record, in his own particular district, the Migration Flight of certain common or fairly well distributed species whose movements in Spring and Autumn may be remarked by the most casual observer of natural phenomena.

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perience of the Sky Lark (*Alauda arvensis*), is that the bird always shuns a valley, and frequents the most elevated pastures during winter.

TABLE I. SHOWING THE DURATION OF FLIGHT OF SPRING MIGRANTS.

ARRIVALS.						SPECIES.	DEPARTURES.					
JAN.	FEB.	MAR.	APR.	MAY.	JUN.		JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
++++	++++	++	× ×	× ×	...	Hobby (*Falco subbuteo*).	...	...	× ×	× ×	+++	+++
++++	++++	×	× × ×	× ×	...	Kestrel (*Falco tinnunculus*).	×	× ×	× × ×	× ×	+++	+++
				× ×	...	Osprey (*Pandion haliaëtus*).	...	×	× ×	× ×	×	
			×	× ×	...	Honey Buzzard (*Pernis apivorus*).	...	...	× × ×	×		
+++++	++	++	× ×	×	...	Hen Harrier (*Circus cyaneus*).	...	...	× ×	×	++	++
×	×	× × ×	× ×	×	...	Song Thrush (*Turdus musicus*).	×	×	× ×	× × ×	× ×	× ++
+	×	× ×	× × ×	×	...	Ring Ouzel (*Merula torquata*).	...	...	× ×	× × × ×		+
			× ×	×	...	Nightingale (*Erithacus luscinia*).	...	× ×	× ×			
+	+	×	× × × × ×		...	Whinchat (*Pratincola rubetra*).	...	× ×	× × ×	×	×	+
			× × ×	× ×	...	Redstart (*Ruticilla phœnicurus*).	...	× ×	× × ×			
	×	× ×	× × ×	×	×	Wheatear (*Saxicola œnanthe*).	×	× ×	× × ×	× ×	×	+
				× × ×	×	Spotted Flycatcher (*Muscicapa grisola*). ...	×	× ×	× × ×			
			× ×	× ×	...	Pied Flycatcher (*Muscicapa atricapilla*). ...	...	× ×	× × ×	×		
			× × × × ×		...	Grasshopper Warbler (*Locustella locustella*).	...	× ×	× × ×			
			× × × × ×		...	Sedge Warbler (*Acrocephalus phragmitis*).	...	× ×	× × ×	×		
			× × × × ×		...	Reed Warbler (*Acrocephalus arundinaceus*).	...	× × × × ×				
				× × ×	...	Marsh Warbler (*Acrocephalus palustris*). ...	...	× × ×	× ×			
			× × ×	× ×	...	Blackcap (*Sylvia atricapilla*).	...	× ×	× × ×	×	×	†
			× × × ×		...	Garden Warbler (*Sylvia hortensis*). ...	...	× × × × ×				
	†	...	× × × ×		×	Whitethroat (*Sylvia cinerea*).	×	× ×	× × ×	× ×		
			× × × ×		...	Lesser Whitethroat (*Sylvia curruca*). ...	×	× ×	× × × ×			
			× × × ×		...	Wood Wren (*Phylloscopus sibilatrix*). ...	...	× ×	× × ×	×		
		×	× × × × ×		..	Willow Wren (*Phylloscopus trochilus*). ...	×	× ×	× × ×	× ×	×	
†	†	× × × ×		× ×	...	Chiffchaff (*Phylloscopus rufus*).	...	× ×	× × ×	× ×	×	†
				× × ×	...	Red-backed Shrike (*Lanius collurio*). ...	...	× ×	× × ×	×	×	
†	†	†	× × × × ×		× ×	Swallow (*Hirundo rustica*).	×	× × × × × ×			×	†
			× × × ×		×	House Martin (*Chelidon urbica*).	×	× × × × × ×			×	†
		†	× ×	× × ×	...	Sand Martin (*Cotyle riparia*).	...	× × × × ×		×	×	

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TABLE II. SHOWING THE DURATION OF FLIGHT OF AUTUMN MIGRANTS.

ARRIVALS.						SPECIES.	DEPARTURES.					
JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.		JAN.	FEB.	MAR.	APR.	MAY.	JUNE.
	×	× ×	× × ×	× ×	...	Short-eared Owl (*Strix brachyotus*). ...	...	...	× × ×	× ×	×	
	×	× ×	× × ×	× ×	..	Missel Thrush (*Turdus viscivorus*). ...	...	×	× ×	× ×		
	×	× ×	× × ×	× ×	×	Redwing (*Turdus iliacus*).	...	×	× ×	× × ×	×	
×	×	× ×	× × ×	× ×	...	Song Thrush (*Turdus musicus*).	×	×	× × ×	× ×	×	
		×	× × ×	× × ×	× ×	Fieldfare (*Turdus pilaris*).	...	×	× ×	× × ×	×	
	×	× ×	× × ×	× × ×	×	Blackbird (*Merula merula*).	×	×	× ×	× ×	×	
×	× ×	× × ×	× × ×	×	×	Robin (*Erithacus rubecula*).	×	×	× ×	× ×	×	
		× ×	× ×	×	...	Black Redstart (*Ruticilla tithys*).	...	...	× ×			
×	×	× ×	× × ×	× ×	×	Goldcrest (*Regulus cristatus*).	...	...	× × ×	× ×	×	
	×	× ×	× × ×	×	...	Hedge Accentor (*Accentor modularis*). ...	...	...	× × ×	× ×	×	
×	×	× × ×	× × ×	× ×	×	Wren (*Troglodytes parvulus*).	...	...	× ×	× ×	× ×	
		×	× × ×	× ×	×	Carrion Crow (*Corvus corone*).	...	...	× × ×	× ×	×	
†	...	×	× × ×	× ×	×	Hooded Crow (*Corvus cornix*).	...	...	× × ×	× ×	×	×
	×	×	× × ×	× ×	×	Rook (*Corvus frugilegus*).	...	×	× × ×	× ×		
			× × ×	× ×	×	Jackdaw (*Corvus monedula*).	...	×	× × ×	× ×		
		×	× ×	× ×	...	Pallas's Gray Shrike (*Lanius major*). ...	×	× ×	× ×	×		
		×	× ×	× ×	...	Great Gray Shrike (*Lanius excubitor*). ...	×	× ×	× ×	×	...	×
× ×	×	× ×	× × ×	× × ×	× ×	Starling (*Sturnus vulgaris*).	×	×	× × ×	× × ×	×	[× × × *Juv. arr.*]
×	×	× ×	× ×	× × ×	× ×	House Sparrow (*Passer domesticus*). ...	...	×	× ×	× ×	×	
×	×	× ×	× × ×	× × ×	× ×	Tree Sparrow (*Passer montanus*). ...	×	×	× ×	× ×	×	×
×	×	× ×	× × ×	× ×	× ×	Greenfinch (*Fringilla chloris*).	×	×	× × ×	×	×	
×	...	...	× × ×	× ×	...	Goldfinch (*Fringilla carduelis*).	...	...	×	× ×	×	
		×	× × ×	× ×	...	Brambling (*Fringilla montifringilla*). ...	...	...	× ×	× ×	×	×
	×	× × × × × ×			× ×	...	Chaffinch (*Fringilla cœlebs*).	...	×	× × ×	× × ×	×
	×	× × ×	× × ×	· ×	×	Siskin (*Fringilla spinus*).	...	...	× ×	× ×	×	
×	×	× × × × × ×			× ×	×	Linnet (*Linota cannabina*).	×	×	× × ×	× × ×	× ×	

×	×	× ×	× × ×	×	×	Twite (*Linota flavirostris*).	...	×	× ×	× ×	×	×
		× ×	× × ×	×	×	Mealy Redpole (*Linota linaria*).	...	×	×	×		
			× ×	×	...	Hawfinch (*Coccothraustes vulgaris*). ...	...	...	×	×	×	
†	†	× ×	× × × × × ×	× ×	Snow Bunting (*Emberiza nivalis*). ...	×	× ×	× × ×	×	†	†
		×	× × ×	× ×	...	Corn Bunting (*Emberiza miliaria*). ...	...	×	× ×	× ×	×	
	×	×	× × ×	× ×	×	Yellow Bunting (*Emberiza citrinella*). ...	...	×	× ×	× ×	×	
		× ×	× × ×	× ×	...	Reed Bunting (*Emberiza schœniclus*). ...	...	×	× ×	×		
	×	× × ×	× × ×	×	×	Meadow Pipit (*Anthus pratensis*). ...	...	×	× × ×	× × ×	×	
×	×	× ×	× × ×	× × ×	× ×	Skylark (*Alauda arvensis*).	...	×	× ×	× × ×	× ×	×	
	×	× ×	× ×	...	...	Kingfisher (*Alcedo ispida*).	...	...	...	×	×	×	
		×	× × ×	× × ×	...	Ring Dove (*Columba palumbus*). ...	...	...	×	× ×	× ×	×	
			× × ×	× × ×	...	Stock Dove (*Columba œnas*).	...	...	...	× ×	×		
×	× ×	× ×	×	× ×	...	Turnstone (*Strepsilas interpres*). ...	...	...	...	×	×	× ×	×
×	× ×	× × ×	× ×	× × ×	×	Golden Plover (*Charadrius pluvialis*). ...	×	× ×	× ×	× × ×	×	×
×	× ×	× × ×	× ×	× × ×	×	Gray Plover (*Charadrius helveticus*). ...	...	...	×	×	× ×	×
×	× ×	× × ×	× ×	× × ×	×	Lapwing (*Vanellus cristatus*).	×	× ×	× ×	× ×	×	×
×	× ×	× × ×	× ×	× ×	×	Curlew (*Numenius arquatus*).	×	× ×	× ×	× ×	× ×	×
×	× × × ×	×	...	...	Whimbrel (*Numenius phœopus*).	...	...	...	× ×	× × ×	×
×	× ×	× ×	× ×	× ×	...	Redshank (*Totanus calidris*).	...	×	× ×	× ×	×	
×	×	× × ×	× × ×	×	...	Bar-tailed Godwit (*Limosa rufa*).... ...	...	...	...	×	× ×	
×	× ×	× × ×	× × × × ×	×	...	Knot (*Tringa canutus*).	...	...	...	×	× ×	×
	× ×	× × ×	× ×	...	...	Dunlin (*Tringa alpina*).	...	...	...	× ×	× ×	× × ×	
		× ×	× × ×	× ×	×	Purple Sandpiper (*Tringa maritima*). ...	...	...	×	×	× ×	
×	× ×	× × ×	× × ×	×	...	Sanderling (*Calidris arenaria*).	...	...	...	× ×	× ×	×
	×	×	× × ×	× × ×	×	Woodcock (*Scolopax rusticola*).	...	×	× × × × ×	×	
	×	× ×	× × ×	× × ×	×	Common Snipe (*Scolopax gallinago*). ...	×	×	× × ×	×	×	
		×	× × × × × ×	...	Jack Snipe (*Scolopax gallinula*). ...	...	×	× × ×	× ×	×	
	×	×	× ×	× ×	× ×	Hooper (*Cygnus musicus*).	× ×	×	×	×	×	

TABLE II. SHOWING THE DURATION OF FLIGHT OF AUTUMN MIGRANTS.

ARRIVALS.						SPECIES.	DEPARTURES.					
JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.		JAN.	FEB.	MAR.	APR.	MAY.	JUN.
			×	×	× ×	Bewick's Swan (*Cygnus bewicki*).	× ×	...	×	×	×	
			× × ×	× ×	...	Bean Goose (*Anser segetum*).	...	...	× ×	× ×		
		×	× × × × ×		...	Pink-footed Goose (*Anser brachyrhynchus*). ...	...	...	× ×	× ×		
	×	×	× ×	× ×	×	Gray-lag Goose (*Anser cinereus*).	...	×	× ×	× ×	×	×
			× ×	× ×	...	White-fronted Goose (*Anser albifrons*). ...	...	...	× ×	× ×	×	
			× × ×	× × ×	...	Lesser White-fronted Goose (*Anser minutus*).	...	...	× ×	× ×	×	
×	×	× ×	× × ×	× × ×	×	Brent Goose (*Bernicla brenta*).	...	×	× × ×	×	×	×
		× ×	× × ×	× × ×	×	White-bellied Brent Goose (*Bernicla glaucogaster*)	...	×	× × ×	×	×	
	×	×	× × ×	× × ×	×	Bernacle Goose (*Bernicla leucopsis*).	×	×	× × ×	× ×	×	
			× ×	× ×	...	Gadwall (*Anas strepera*).	×	×	× ×	× ×		
		×	× ×	× ×	...	Pintail (*Anas acuta*).	...	×	× ×	× ×	×	
	×	× ×	× × ×	× ×	×	Wigeon (*Anas penelope*).	...	...	× ×	× ×	×	×
	×	× ×	× × ×	× ×	×	Teal (*Anas crecca*).	...	...	× × ×	× ×	×	×
	×	×	× × ×	× ×	...	Shoveller (*Anas clypeata*).	...	...	×	× ×	× ×	
×	×	× ×	× × ×	× × ×	×	Mallard (*Anas boschas*).	...	×	× × ×	× ×	×	
		×	× ×	×	...	Pochard (*Fuligula ferina*).	...	×	× ×	× ×		
	×	×	× ×	× ×	...	Scaup (*Fuligula marila*).	×	×	× ×	× ×	×	
		×	× ×	× ×	...	Tufted Duck (*Fuligula cristata*).	...	...	× ×	× ×		
		×	× ×	× ×	...	Golden-eye (*Clangula clangula*).	...	...	×	× ×		
			× × ×	× ×	...	Long-tailed Duck (*Harelda glacialis*). ...	×	×	× ×	×		
×	×	× ×	× × ×	× ×	×	Common Scoter (*Œdemia nigra*).	...	...	×	× ×	× ×	
	×	×	×	×	×	Velvet Scoter (*Œdemia fusca*).	...	×	×	×	×	
			× ×	× ×	×	Goosander (*Mergus merganser*).	...	×	× ×	×	×	

NOTE.—The majority of these species breed in the British Isles, but are either increased in numbers or replaced by migratory individuals in autumn. † Denotes abnormal appearances.

TABLE III. SHOWING THE DURATION OF FLIGHT OF COASTING MIGRANTS.

NORTHWARDS.						SPECIES.	SOUTHWARDS.					
JAN.	FEB.	MAR.	APR.	MAY.	JUN.		JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
			×	×	...	Rough-legged Buzzard (*Archibuteo lagopus*). ...	...	...	×	× ×	× ×	
†	×	× × ×	× ×	× ×	..	Pied Wagtail (*Motacilla yarrellii*).	×	× ×	× × ×	× × ×	×	†
†	†	× ×	× × ×	× ×	...	Gray Wagtail (*Motacilla sulphurea*).	...	×	× × ×	× × ×	†	†
†	×	× ×	× × ×	× ×	...	Rock Pipit (*Anthus obscurus*).	...	×	× × ×	× × ×	× ×	†
			×	×	×	Spoonbill (*Platalea leucorodia*).	...	×	×			
†	†	†	×	...	...	Little Crake (*Crex parva*).	...	...	×	†	†	†
		×	×	×	...	Crane (*Grus cinerea*).	...	...	...	×	×	
		×	× × ×	× ×	...	Ringed Plover (*Ægialitis hiaticula*).	×	×	× × ×	× ×	×	
			× × × ×		×	Dotterel (*Eudromias morinellus*).	×	×	× × ×	×		
†	†	×	×	× ×	×	Gray Plover (*Charadrius helveticus*).	×·	× ×	× × ×	× ×	× × ×	× †
	×	...	×	×	...	Avocet (*Recurvirostra avocetta*).	...	×	×			
†	†	†	× ×	× × ×	×	Whimbrel (*Numenius phæopus*).	×	× × × ×		×	†	†
			×	× ×	×	Ruff (*Machetes pugnax*).	...	×	× × ×	×	×	
†	†	×	× ×	× ×	...	Green Sandpiper (*Totanus ochropus*).	×	× ×	× ×	†	†	†
			× ×	× ×	...	Wood Sandpiper (*Totanus glareola*).	...	× ×	× ×			
†	×	× ×	× ×	×	...	Redshank (*Totanus calidris*).	×	× ×	× ×	× ×	× ×	†
		×	×	...	...	Dusky Redshank (*Totanus fuscus*).	...	×	× ×			
†	†	×	× × ×		...	Greenshank (*Totanus glottis*).	×	×	× × ×	× × ×	†	†
†	†	†	×	× ×	×	Knot (*Tringa canutus*).	×	× ×	× × ×	× × ×	× ×	†
†?	†?	†?	×	×	×	Curlew Sandpiper (*Tringa subarquata*). ...	×	×	× ×	× ×	†?	†?
†	†	×	× ×	× × ×	...	Dunlin (*Tringa alpina*).	...	× ×	× × ×	× ×	†	†
			×	×	...	Little Stint (*Tringa minuta*).	...	...	× ×	× ×		
			×	× ×	...	Temminck's Stint (*Tringa temminckii*).	...	...	× ×	×		
†	†	†	× ×	× ×	×	Sanderling (*Calidris arenaria*).	×	× ×	× × ×	× × ×	×	†
†	×		× × × ×	×	...	Woodcock (*Scolopax rusticola*).	...	×	×	× × ×	× × ×	× †

			× ×	× ×	...	Black Tern (*Sterna nigra*).	...	× ×	×	×					
†	†	×	×	...	...	Great Skua (*Stercorarius catarrhactes*). ...	...	...	×	× ×	× ×	†	†		
†	†	×	×	...	...	Richardson's Skua (*Stercorarius richardsoni*). ...	...	...	×	× ×	× ×	†	†		
†	†	×	×	...	...	Pomarine Skua (*Stercorarius pomarinus*). ...	...	...	...	× ×	× ×	†	†		
†	×	×	...	...	...	Black-necked Grebe (*Podiceps nigricollis*). ...	...	...	...	...	×	×	†		
†	×	× ×	× ×	×	×	Gray-lag Goose (*Anser cinereus*).	...	×	×	× ×	× ×	× ×	× †		
†	†	†	× ×	× ×	...	Bean Goose (*Anser segetum*).	...	...	...	× × ×	× ×	†			
†	†	×	× ×	×	...	White-fronted Goose (*Anser albifrons*). ...	...	...	...	× × ×	× × ×	†			
†	†	× ×	× ×	×	...	Lesser White-fronted Goose (*Anser minutus*).	...	...	...	× × ×	× × ×	†			
†	×	× × ×	×	×	×	Brent Goose (*Bernicla brenta*).	×	×	× ×	× × ×	× × ×	× †			
†	×	× × ×	×	×	...	White-bellied Brent Goose (*Bernicla glaucogaster*).	...	...	× ×	× × ×	× × ×	× †			
†×	×	× × ×	× ×	×	...	Bernacle Goose (*Bernicla leucopsis*).	...	×	×	× × ×	× × ×	× †			
†×	×	× ×	× ×	...	...	Gadwall (*Anas strepera*).	...	...	...	× ×	× ×	†			
†	×	× ×	× ×	×	...	Pintail (*Anas acuta*).	...	...	×	× ×	× ×	†			
†	†	× ×	× ×	×	×	Wigeon (*Anas penelope*).	...	×	× ×	× × ×	× ×	× †			
†	†	× × ×	× ×	×	×	Teal (*Anas crecca*).	...	×	× ×	× × ×	× ×	× †			
†	†	×	× ×	× ×	...	Shoveller (*Anas clypeata*).	...	×	×	× × ×	× ×	†			
†	×	× × ×	× ×	×	...	Mallard (*Anas boschas*).	×	×	× ×	× × ×	× × ×	× †			
†	×	× ×	× ×	...	...	Pochard (*Fuligula ferina*).	...	...	×	× ×	×	†			
†×	†×	× ×	× ×	×	...	Scaup (*Fuligula marila*).	...	×	×	× ×	× ×	†			
†	†	× ×	× ×	...	...	Tufted Duck (*Fuligula cristata*).	..	×	× ×	× ×	†	†			
†	†	×	× ×	...	...	Golden-eye (*Clangula clangula*).	...	...	×	× ×	× ×	†			
†×	†×	× ×	×	...	...	Long-tailed Duck (*Harelda glacialis*). ...	...	...	...	× ×	× ×	†			
†	†	×	× ×	× ×	...	Common Scoter (*Œdemia nigra*).	×	×	× ×	× × ×	× ×	× †			
†	†×	×	×	×	...	Velvet Scoter (*Œdemia fusca*).	...	×	×	×	×	× †			
†	†×	× ×	×	×	...	Goosander (*Mergus merganser*).	...	...	...	× ×	× ×	× †			
†	†	× ×	× ×	×	...	Red-breasted Merganser (*Mergus serrator*). ...	...	...	×	× ×	× ×	× †			

I

NOTE.—The number of crosses indicates the intensity of Migration. Where an obelisk is inserted it denotes that a certain number of individuals remain in our islands during the winter, or are resident with us.

TABLE IV. SHOWING THE PRINCIPAL MOVEMENTS OF NOMADIC MIGRANTS.

AUTUMN (Southwards).						SPECIES.	WINTER AND SPRING (Northwards).					
JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.		JAN.	FEB.	MAR.	APR.	MAY.	JUNE.
				WINTER		Hawk Owl (*Surnia funera*).						
			×	×	...	Tengmalm's Owl (*Noctua tengmalmi*). ...						
			×	×	×	Snowy Owl (*Surnia nyctea*).	×	×				
						Eagle Owl (*Bubo maximus*).	...	×	...	×		
×	×	× ×	× × ×	×	× ×	Great Titmouse (*Parus major*).	...	...	× ×	× ×	×	
×	×	× ×	× × ×	×	...	Blue Titmouse (*Parus cæruleus*).	...	...	× ×	× ×	×	
×	×	× ×	× × ×	×	...	Coal Titmouse (*Parus ater*).	...	...	× ×	× ×	×	
×	×	×	× × ×	...	...	Long-tailed Titmouse (*Acredula caudata*).	...	...	× ×	× ×	×	
			×	...	...	Nutcracker (*Nucifraga caryocatactes*). ...						
			×	× ×	× ×	Waxwing (*Ampelis garrulus*).	× ×	×				
×	...	...	×	...	×	Common Crossbill (*Loxia curvirostra*). ...						
						Parrot Crossbill (*Loxia pityopsittacus*). ...						
	×	×	×	×	×	White-winged Crossbill (*Loxia bifasciata*).	×	×	×	×	×	
		×	×	...	...	American ,, ,, (*Loxia leucoptera*).	...	×				
						Pine Grosbeak (*Pinicola enucleator*). ...						
		×	×	×	×	Lapland Bunting (*Emberiza lapponica*). ...	×	×				
			× ×	× ×	× ×	Shore Lark (*Otocoris alpestris*).	×	× ×	×	×		
×	× ×	× ×	× ×	×	...	Heron (*Ardea cinerea*).	...	×	×	×		
			×	×	× ×	Bittern (*Botaurus stellaris*).	×	×				

| | | |

TABLE V. SHOWING THE MOVEMENTS OF VERTICAL MIGRANTS.

ASCENDING.						SPECIES.	DESCENDING.					
JAN.	FEB.	MAR.	APR.	MAY.	JUNE.		JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
		× ×	×	...	...	Merlin (*Falco æsalon*).	...	×	× ×	×		
	×	× ×	×	...	...	Stonechat (*Pratincola rubicola*).	...	...	×	× ×		
	×	× × ×		×	...	Linnet (*Linota cannabina*).	...	×	× ×	×		
		×	× ×	×	...	Twite (*Linota flavirostris*).	...	×	× ×	×		
		×	× ×	×	...	Lesser Redpole (*Linota rufescens*). ...	...	×	× ×	×		
		× × ×		...	...	Pied Wagtail (*Motacilla yarrellii*). ...	...	×	× ×			
	×	× ×	×	...	...	Gray Wagtail (*Motacilla sulphurea*). ...	...	...	×	× ×		
		× × ×		...	...	Meadow Pipit (*Anthus pratensis*).	...	...	×	× ×		
	×	× ×	...	...	...	Wood Lark (*Alauda arborea*).	...	...	×	× ×	×	
	×	× ×	× ×	...	...	Sky Lark (*Alauda arvensis*).	...	...	×	× ×		
		× ×	× ×	×	...	Golden Plover (*Charadrius pluvialis*). ...	...	×	× ×	×		
	×	× ×	×	...	...	Lapwing (*Vanellus cristatus*).	...	×	× ×	×		
		× ×	× ×	×	...	Curlew (*Numenius arquatus*).	...	×	× ×	×		
		× ×	×	...	...	Dunlin (*Tringa alpina*).	...	×	× ×			

NOTE.—The number of crosses indicates the intensity of Migration.

TABLE VI. SHOWING THE PRINCIPAL OCCURRENCES OF ABNORMAL MIGRANTS.

JAN	FEB.	MAR.	APR.	MAY.	JUNE.	SPECIES.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
			SPRING	×	...	Orange-legged Hobby (*Falco vespertinus*).	...	...	×			
						Brown Jer-Falcon (*Falco gyrfalco*).... ...	...	...	...	×	WIN	TER
×	...	×	...	...	...	Iceland Jer-Falcon (*Falco gyrfalco candicans*).	...	...	...	...	WIN	TER
		×	...	...	...	White Jer-Falcon (*Falco candicans*). ...	...	...	...	...	WIN	TER
				×	...	Lesser Kestrel (*Falco cenchris*).	...	...	...	...	×	
						Swallow-tailed Kite (*Elanoides furcatus*).	...	...	×			
				×	...	Black Kite (*Milvus ater*).						
×	...	...	...	...	...	Lesser Spotted Eagle (*Aquila nævia*). ...	...	...	...	×	×	×
	×	...	...	...	...	American Goshawk (*Astur atricapillus*). ...						
						Little Owl (*Noctua noctua*).*						
		×	...	...	...	American Hawk Owl (*Surnia hudsonia*).	...	×	...	...	×	×
				×	...	Scops Owl (*Scops scops*).	...	...	...	...	×	
×	...	...	...	...	...	White's Thrush (*Geocichla varia*).	...	...	...	×	×	×
						Siberian Thrush (*Geocichla sibirica*). ...	...	...	...	...	WIN	TER
	×	...	...	...	...	Black-throated Ouzel (*Merula atrigularis*).	...	...	...	×	...	×
						Black-bellied Dipper (*Cinclus melanogaster*).	...	...	...	×	WIN	TER
	×	...	...	× × ×	...	Arctic Blue-throat (*Erithacus suecica*). ...	×	...	× × ×	× ×		
				×	×	Rock Thrush (*Monticola saxatilis*). ...						
						Desert Chat (*Saxicola deserti*).	...	...	...	×	×	×
				×	...	Black-throated Chat (*Saxicola stapazina*).						
						Isabelline Chat (*Saxicola isabellina*). ...	...	...	...	...	×	
×	...	...	...	...	...	Red-breasted Flycatcher (*Muscicapa parva*).	...	...	×	×	×	
						White-collared Flycatcher (*Muscicapa collaris*).						
						Aquatic Warbler (*Acrocephalus aquaticus*).	...	...	...	×		
				×	×	Great Reed Warbler (*Acrocephalus turdoides*).*	...	...	×			
					×	Icterine Warbler (*Hypolais hypolais*). ...	...	...	×			
						Barred Warbler (*Sylvia nisoria*).	..	×	×			
					×	Orphean Warbler (*Sylvia orphea*). ...	×					
						Rufous Warbler (*Sylvia galactodes*). ...	...	...	×	×		

						Yellow-browed Warbler (*Phylloscopus superciliosus*).	...	...	×	×			
							...	...	×	×			
						Firecrest (*Regulus ignicapillus*).	...	×	...	...	WINTER		
						Ruby-crowned Wren (*Regulus calendula*).*							
						Alpine Accentor (*Accentor alpinus*). ...	...	×	...	...	×		
				×	...	Wall Creeper (*Tichodroma muraria*). ...	...	...	...	×			
			× ×	×	...	Golden Oriole (*Oriolus galbula*).	...	...	...	×			
×	...	...	...	...	...	Gold-vented Thrush (*Pycnonotus capensis*).							
				×	...	Lesser Gray Shrike (*Lanius minor*). ...	...	...	×	...	×		
				×	...	Woodchat Shrike (*Lanius rufus*).							
						Rose-coloured Pastor (*Pastor roseus*). ...	...	×	AUTUMN				
						Red-winged Starling (*Agelæus phœniceus*).	...	...	...	×			
						Rusty Grakle (*Scolecophagus ferrugineus*).	...	...	...	×			
		×	...	...	...	Meadow Starling (*Sturnella magna*). ...	...	...	...	×			
						Scarlet Rose Finch (*Carpodacus erythrinus*).	...	...	×	×			
			×	...	...	Canary (*Fringilla canaria*).	...	...	...	...	×		
	×	...	×	...	×	Serin (*Fringilla serinus*).	...	...	AUTUMN				
			×	...	...	Greenland Redpole (*Linota hornemanni*).							
						White-throated Sparrow (*Zonotrichia albicollis*)	...	×					
						Brandt's Siberian Bunting (*Emberiza cioides*).	...	...	...	×			
						Rustic Bunting (*Emberiza rustica*). ...	...	...	×	×	×		
						Little Bunting (*Emberiza pusilla*). ...	...	...	...	...	×		
			×	×	...	Ortolan Bunting *Emberiza hortulana*). ...	...	...	×	×	×		
					×?	Black-headed ,, (*Emberiza melanocephala*).	×?	...	...	...	×		
						White-bellied Swallow (*Tachycineta bicolor*).*							
						Purple Martin (*Progne purpurea*).	...	...	×				
		×	×	×	...	Red-throated Pipit (*Anthus cervinus*). ...							
	×	...	...	...	...	Richards' Pipit (*Anthus richardi*). ...	...	...	...	×			
						Tawny Pipit (*Anthus campestris*).	...	×	× ×	× ×			
						Alpine Pipit (*Anthus spinoletta*).	...	...	...	×	AUTUMN		
					×	Crested Lark (*Alauda cristata*).	...	...	×	×			
			×	...	...	Short-toed Lark (*Alauda brachydactyla*). ...	×	...	×	×	×	×	

NOTE.—An * denotes that the month of capture is unknown.

TABLE VI. SHOWING THE PRINCIPAL OCCURRENCES OF ABNORMAL MIGRANTS.

JAN.	FEB.	MAR.	APRIL.	MAY.	JUNE.	SPECIES.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
						White-winged Lark (*Alauda sibirica*). ...	...	...	...	...	×	
						Calandra Lark (*Alauda calandra*).* ...						
					×	Alpine Swift (*Cypselus melba*).	×	×	×	×		
						Needle-tailed Swift (*Chætura caudacuta*).	×					
					×	Isabelline Nightjar (*Caprimulgus ægyptius*).						
						Red-necked Nightjar (*Caprimulgus ruficollis*).	...	...	...	×		
				×	×	Bee-eater (*Merops apiaster*).	...	...	...	×		
				×	...	Roller (*Coracias garrula*).	...	...	...	×	AUTUMN	
						Indian Roller (*Coracias indicus*).	...	...	...	×		
						Belted Kingfisher (*Ceryle alcyon*).	...	...	...	×	×	
		×	...	...	...	Great Spotted Cuckoo (*Cuculus glandarius*).	...	×				
						Yellow-billed Cuckoo (*Coccyzus americanus*).	...	...	...	× ×		
						Black-billed ,, (*Coccyzus erythrophthalmus*).	...	...	×			
						Passenger Pigeon (*Ectopistes migratorius*).	×	...	...	×	...	×
						Eastern Turtle Dove (*Turtur orientalis*). ..	...	...	...	×		
×	×	×	×	× ×	× ×	Pallas's Sand Grouse (*Syrrhaptes paradoxus*).	×	×	×	×	×	
		×	...	...	...	Purple Heron (*Ardea purpurea*).	...	...	...	×		
	×	...	...	×	×	Great White Egret (*Ardea alba*).	...	...	×			
×	...	...	...	...	×	Little Egret (*Ardea garzetta*).	×					
				× ×	...	Squacco Heron (*Ardea comata*).	SUMMER		...	...	×	
			×	...	...	Buff-backed Heron (*Ardea bubulcus*). ...	...	...	...	×		
				×	×	Night Heron (*Nycticorax nycticorax*). ...	...	...	AUTUMN			
						Little Green Heron (*Butorides virescens*).	...	...	...	×		
		×	...	...	...	American Bittern (*Botaurus lentiginosus*).	...	...	...	×	×	×
			SPRING		...	Little Bittern (*Botaurus minutus*). ...	...	...	...	×	AUTUMN	
			SPRING		...	Glossy Ibis (*Ibis falcinellus*).	...	...	×	×		
			×	×	...	White Stork (*Ciconia alba*).						

NOTE.—An * denotes that the month of capture is unknown.

			×	...	Black Stork (*Ciconia nigra*).	...	×	...	×	×		
			×	...	Demoiselle Crane (*Grus virgo*).							
					Macqueen's Bustard (*Otis macqueeni*). ...	...	...	...	×			
			×	...	Little Ringed Plover (*Ægialitis minor*). ...	...	×	...	×			
		×	...	...	Killdeer Plover (*Ægialitis vocifera*). ...	×						
				×	Caspian Sand Plover (*Ægialophilus asiaticus*).							
					Sociable Lapwing (*Vanellus gregarius*). ...	...	...	AUTUMN				
					Asiatic Golden Plover (*Charadrius fulvus*).	...	...	...	...	...	×	
					American Golden ,, (*Charadrius virginicus*).	...	...	...	...	×		
		×	...	...	Cream-coloured Courser (*Cursorius gallicus*).	...	...	...	× × ×	×		
		SPRING		...	Common Pratincole (*Glareola pratincola*).	...	×	×	×			
			×	×	Common Stilt (*Himantopus melanopterus*).	×	...	AUTUMN (*rarely*)				
					Esquimaux Curlew (*Numenius borealis*). ...	...	×	× ×	×			
					Bartram's Sandpiper (*Totanus bartrami*). ...	...	...	...	×	×	×	
	×	...	×	...	Spotted Sandpiper (*Totanus macularius*).	...	×	...	×			
					Solitary Sandpiper (*Totanus solitarius*). ...	...	...	×	×			
					Yellowshank (*Totanus flavipes*).	...	...	×	×			
					Red-breasted Snipe (*Ereunetes griseus*). ...	...	×	× ×	× ×			
					Bonaparte's Sandpiper (*Tringa bonaparti*).	...	...	...	×	×		
		×	×	...	Broad-billed Sandpiper (*Tringa platyrhyncha*).	...	×	...	×			
			×	×	Pectoral Sandpiper (*Tringa pectoralis*). ...	...	×	×	× ×	×		
					American Stint (*Tringa minutilla*). ...	...	...	×	×			
			×	...	Buff-breasted Sandpiper (*Tryngites rufescens*).	...	...	×	×			
			×	...	Great Snipe (*Scolopax major*).	...	×	×	×			
			× ×	×	White-winged Black Tern (*Sterna leucoptera*).	...	...	...	×	×		
			×	×	Whiskered Tern (*Sterna hybrida*). ...	...	×	×				
		×	× ×	...	Gull-billed Tern (*Sterna anglica*).	× ×	...	×				

TABLE VI. SHOWING THE PRINCIPAL OCCURRENCES OF ABNORMAL MIGRANTS.

JAN.	FEB.	MAR.	APRIL.	MAY.	JUNE.	SPECIES.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
			×	×	×	Caspian Tern (*Sterna caspia*).	×	×	...	×	×	
					×	Sooty Tern (*Sterna fuliginosa*).	...	...	...	×		
						Smaller Sooty Tern (*Sterna anæstheta*). ...	...	...	×			
						Noddy Tern (*Sterna stolida*).*						
×	×	...	×	...	...	Bonaparte's Gull (*Larus philadelphia*). ...	×	...	...	...	×	
						Mediterranean Black-headed Gull (*Larus me-*						
×	...	...	...	...	...	*lanocephalus*).	...	...	...	...	...	×
				×?	×?	Great Black-headed Gull (*Larus ichthyaetus*).						
			×	×	...	Dusky Shearwater (*Puffinus obscurus*). ...						
						Sooty Shearwater (*Puffinus griseus*). ...	×	×				
				×	...	Wilson's Petrel (*Oceanites wilsoni*). ...	...	×?	...	...	×	
						Cape Petrel (*Daption capensis*).	...	...	...	×		
		×?	×?	...	...	Capped Petrel (*Œstrelata hæsitata*). ...						
						Collared Petrel (*Œstrelata torquata*). ...	...	...	...	...	...	×
				×	...	Bulwer's Petrel (*Bulweria columbina*). ...						
						Trumpeter Swan (*Cygnus buccinator*). ...	...	...	...	×		
	×	...	...	...	...	American Swan (*Cygnus americanus*). ...	...	...	...	...	...	×
						Lesser Snow Goose (*Anser hyperboreus*). ...	...	× ?	...	×	×	
×	...	...	...	...	...	Red-breasted Goose (*Bernicla ruficollis*). ...	...	...	...	WINTER		
×	...	×	...	...	...	Ruddy Sheldrake (*Tadorna rutila*). ...	×	×	×	×		
×	×	...	×	...	...	American Wigeon (*Anas americana*). ...						
×	...	...	...	...	...	Blue-winged Teal (*Anas discors*).	..	...	×			
						American Teal (*Anas carolinensis*). ...	...	...	...	...	×	
×	...	...	...	...	...	Red-crested Pochard (*Fuligula rufina*). ...	×	...	...	...	WINTER	
×	SPRING		...	...	...	White-eyed Pochard (*Fuligula nyroca*). ...	...	...	...	...	WINTER	
×	...	...	...	...	...	Buffel-headed Duck (*Clangula albeola*). ...	...	...	...	WINTER		
×	...	...	...	...	...	Ring-necked Duck (*Fuligula collaris*). ...						
×	...	...	...	...	...	Hooded Merganser (*Mergus cucullatus*). ...	...	...	...	...	...	×

NOTE.—Where no signs are affixed the months are unknown, but the season is inserted.
An * denotes that the month of capture is unknown.

TABLE OF MIGRATION FLIGHT FOR YEAR 189... IN THE AREA OR DISTRICT OF .....

JAN.	FEB.	MAR.	APR.	MAY	JUN.	SPECIES.	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
						Song Thrush						
						Redwing						
						Fieldfare						
						Ring Ouzel						
						Nightingale						
						Whinchat						
						Redstart						
						Wheatear						
						Spotted Flycatcher ...						
						Grasshopper Warbler						
						Sedge Warbler						
						Reed Warbler						
						Blackcap						
						Garden Warbler ...						
						Whitethroat						
						Lesser Whitethroat ...						
						Wood Wren						
						Willow Wren						
						Chiffchaff						
						Red-backed Shrike ...						
						Goldcrest						
						Hooded Crow						
						Brambling						
						Snow Bunting						
						Yellow Wagtail ...						
						Tree Pipit						
						Swallow						
						House Martin						
						Sand Martin						
						Nightjar						
						Cuckoo						
						Swift						
						Wryneck						
						Turtle Dove						
						Corn Crake						
						Stone Curlew						
						Turnstone						
						Golden Plover						
						Whimbrel						
						Common Sandpiper ...						
						Knot						
						Sanderling						
						Woodcock						
						Jack Snipe						
						Gray-lag Goose ...						
						Bean Goose						
						Brent Goose						
						Wigeon						
						Tufted Duck						
						Common Scoter ...						

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